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THE WORLD ENERGY CRISIS

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How serious is the world's energy crisis? How is it affecting the economies of the various nations of the world? In this issue, eight specialists explore the ramifications of the energy crisis. As our introductory article sees it, "The energy problem is neither the greatest problem of our times nor the moral equivalent of war. Nonetheless, it is a problem that will cost us a great deal if we refuse to confront it or if we make hasty, uninformed decisions."

The Nature of the Energy Crisis

BY LESTER B. LAVE

Professor of Economics, Carnegie-Mellon University

THE world energy crisis is oversold. It is no more a crisis than middle-age worry about death from old age. The end result is certain, but that end is some decades in the future. Just as slowly and inexorably as we get older, slowly and inexorably we use up our natural resources.

There is a world energy problem.[1] The price of petroleum quadrupled within twelve months in 1973-1974; the prices of many other goods went up in response to oil price increases; a resulting economic downturn, worldwide in scope, became the deepest recession since the 1930's; and the fabric of international economic and political cooperation became threadbare, if not torn, by the Arab oil embargo and price increases. Americans began to realize that the United States was not so rich and secure as they had assumed; many of the developing nations found their hopes dashed by the sharp increase in petroleum prices and generally uneasy world economy.

But the energy situation is not the moral equivalent of war, in spite of President Jimmy Carter's statement in his address to the nation on April 18, 1977. Consumers can buy all the gasoline and other petroleum products they desire. If there was a problem in the nation last winter in obtaining natural gas, the problem was caused by extraordinary weather or inept government regulations, not by a crisis in energy.

Nonetheless, sometime in the next half century, perhaps as soon as the 1990's, the world will begin to run out of petroleum and natural gas. We have already begun to run out of cheap oil and natural gas. If we continue increasing our appetites for these energy resources, there will be a world energy crisis, possibly as early as the middle of the next decade. If we fail to heed the warning and take constructive action, the costs of the crisis will be large, possibly ruinous. With intelligent action, the problem may result in only a minor sacrifice in our economic well-being. But, failing to heed the warning will probably entail more serious problems for the environment and for international relations than for our personal consumption.

The human race uses large quantities of energy. The Dalmatian Coast, that part of Yugoslavia that borders the Adriatic Sea, was once a place of tall trees. But the Romans cut the trees and allowed the top soil to wash away; now little grows among the rocks.[2] Indeed, the general bareness of the Mediterranean basin is testimony to the long-term destructive effects of using the environment unwisely.

Five thousand years ago, the only forms of energy known to man were fire and his own labor. Sometime later, animal power was added to this; but until a few hundred years ago, wood (often in the form of charcoal) was the principal fuel used by the human race. However in the last few centuries, wood began to grow scarce, and there was a shift to coal. In the nineteenth century, coal was displaced by petroleum and natural gas; now these are running out.[3]

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[1] H. Brown, "Energy in our Future," in J. Hollander, ed., *Annual Review of Energy,* vol. 1 (Palo Alto, Calif.: Annual Reviews, Inc., 1976); and W. Hafele and W. Sassin, "The Global Energy System," in J. Hollander, M. Simmons and D. Wood, eds., *Annual Review of Energy,* 1977.

[2] M. I. Rostovstev, *Social and Economic History of the Roman Empire* (Oxford: Clarendon Press, 1973).

[3] For discussion of the general issues, see *Annual Review of Energy,* vols. 1 and 2, and National Academy of Sciences.

It became evident during the industrial revolution that industrialization depended on fossil fuels. The growing shortage of wood was evidence the world's energy supply could not be taken for granted. There were many warnings about running out of wood, coal, natural gas, and oil.

After World War II, the prices of raw materials rose sharply and general concern was voiced about running out of natural resources. One of the most influential spokesmen was M. King Hubbert, who predicted that the peak rate of extraction of petroleum in the 48 continental states would be reached in 1970 and that peak extraction of natural gas would be reached a few years later.[4] Hubbert's predictions have proved to be alarmingly accurate and have raised the specter of running out of oil and natural gas in the near future.

In the early 1970's, the Club of Rome commissioned Dennis Meadows and his colleagues to investigate the availability of natural resources and the implications of an increasing population and economic growth. The Meadows study pointed out that the world could not continue to experience rapid population growth and rapid economic growth. Under such conditions, Meadows predicted that we would abruptly run out of natural resources and that the economy would collapse, perhaps as soon as the early twenty-first century.[5]

The 1973 Arab oil embargo and the quadrupling of prices by OPEC set off a sharp rise in the prices of other energy forms. These, together with the fact that oil production in the United States peaked in 1970 and natural gas production in the United States peaked in 1973, seemed to confirm all the worst predictions about running out of energy.

In contrast to these voices of immediate concern are the findings of the Paley Commission. President Truman appointed the Materials Policy (Paley) Commission to study whether we were running out of natural resources. The Paley Commission and more recent work revealed that many previous forecasts about the availability of natural resources were unduly pessimistic. Over the last century, the prices of virtually all raw materials have declined; this was especially true of energy delivered to consumers.[6] While one cannot be sanguine about running out of raw materials, this team concluded that there is no immediate cause for concern.

THE NATURE OF THE PROBLEM

The population of the world has been growing rapidly for the last several centuries, and during the twentieth century, the rate of population growth has increased.[7] It is evident that the population of the world cannot continue to grow at this rate.

While the world population has been growing rapidly, the economies of many nations have also been growing. Gross national product in the United States has been increasing at over 4 percent per year for a century. There have also been high growth rates for the economies of West Europe, the Soviet Union, and Asian countries like Japan. Just as a growing population requires energy to support it, so does growing economic activity. In large part, this economic growth has been fostered by cheap energy.

The poignancy of the situation is illustrated by the reactions to the fourfold increase in oil prices. The rich nations have complained and have had to make adjustments, but the poor nations of the world, which simply could not afford to continue using oil, saw their hopes for development smashed or at least set back by the increased price of oil.

Another manifestation of the energy problem is our wasteful attitude toward energy.[8] Early in this century, a great deal of petroleum was spilled, and, until recently, most natural gas was flared. Energy has been so abundant and so cheap that it did not seem worthwhile to try to conserve it. However, the end of cheap energy sources is apparent. Oil resources on the Arabian peninsula are so plentiful that the cost of producing a barrel is less than one dollar. But even this resource is finite. We have already had to take oil from the north slope of Alaska and the North Sea, whose costs by the time the oil gets to the United States amount to more than $10 per barrel.

Although the era of cheap energy is at an end, we see no decrease in population growth and no evidence that the expectations have changed, either of the rich countries for continued growth or of the poor countries for catching up to the rich countries.

IS THE PROBLEM REAL?

Energy resources are concentrated in a few nations, with ownership and distribution in the hands of a few multinational corporations.[9] This is especially evident in the case of petroleum, where a handful of nations control the bulk of current oil reserves and production, and where seven major multinational oil companies control the bulk of oil extraction and distribution in the world. Within the United States, the large oil companies began in the last two decades to acquire large holdings of other energy resources. These companies

[4]M. Hubbert, "Energy from Fossil Fuels," *Science,* vol. 109 (1949), pp. 103-109.

[5]D. Meadows et al., *The Limits to Growth: A Report of the Club of Rome's Project on the Predicament of Mankind* (New York: Universe, 1972).

[6]H. Barnett and C. Morse, *Scarcity and Growth: The Economics of Natural Availability* (Baltimore: Johns Hopkins University Press, 1963).

[7]J. Matras, *Populations and Societies* (Englewood Cliffs, N.J.: Prentice-Hall, 1973).

[8]R. Socolow, "The Coming of Age of Conservation" in *Annual Review,* vol. 2; L. Schipper, "Raising the Productivity of Energy Utilization," *Annual Review,* vol. 1; and J. Darmstadter, J. Dunkerley and J. Alterman, *How Industrial Societies Use Energy: A Comparative Study* (Baltimore: Johns Hopkins University Press, 1977).

[9]F. Wyant, "The Role of Multinational Oil Companies in World Energy Trade," *Annual Review of Energy,* vol. 2.

now control the bulk of our coal, oil shale and uranium resources.

If the cost of extracting oil in the Arabian Peninsula is less than a dollar, how can the Organization of Petroleum Exporting Countries (OPEC) sell this oil for more than $12 per barrel? The juxtaposition of low production costs and high prices has led many people to blame the energy problem on a conspiracy. In their view, a few nations or the large oil companies are responsible for all our problems.

There can be no doubt that the Arab oil embargo and the quadrupling of oil prices have disrupted our lives and our economy. The prices of other energy resources rose along with petroleum prices, and consumers in the United States experienced gasoline shortages and shortages of natural gas and home heating oil. However, the conspiracy theory seems weak. Given our large and increasing appetites for oil, the world demand for oil would soon be pressing the available supply. At that point, there would have been natural increases in oil prices. Even prior to 1973, there were increases in oil prices. At worst, OPEC anticipated by a few years the increase in prices that would have come in any case. While some short-term manifestations of the energy problem might conceivably be ascribed to a conspiracy, the long-term problems are evident, and it is fortunate that we have had decades of warning.

Cutting trees for fuel has often led to vast environmental change. Many forests are gone forever; sometimes erosion has prevented regrowth. Coal mining produces acid mine damage and subsidence; burning the coal vents particulates, sulfur oxides, nitrogen oxides, and carbon dioxide.[10] The resulting air pollution kills vegetation and results in acid rain, which kills plants directly and can upset the balance of lakes to the point of killing fish. Aside from oil spills, extracting and transporting petroleum and natural gas has few environmental consequences; burning these fuels leads to the same problems as burning coal but to a lesser magnitude. Mining uranium also leads to environmental problems; mining, milling, fuel processing, operating light water reactors, and handling spent fuel and radioactive wastes release radionuclides into the environment.[11]

In addition, coal mining involves risks to health in the form of accidents and occupational disease; for example, coal miners get coal workers' pneumoconiosis (black lung). Burning fossil fuels causes air pollution that can cause illness and death.[12] Many adverse health effects are associated with each of the energy-producing technologies.

There are also long-term risks associated with each energy technology. Burning fossil fuels releases carbon dioxide which, on building up in the atmosphere, causes an increase in atmospheric temperature and resulting weather changes. Nuclear fuels create long-lived radionuclides that must be isolated from contact with humans and the rest of the ecology for periods up to millions of years.

All energy technologies involve risks; all energy technologies also have adverse environmental impacts. These adverse effects have been largely ignored. Because of mankind's increased use of energy, the world's ecology has changed. Some changes are regarded as beneficial, as when the cooling water from a plant warms a lake and causes the fish to grow more rapidly. Some changes are deplorable, as when the acid runoff from coal mines pollutes rivers or when unrestored land after strip mining resembles a moonscape.

Before we continue to increase energy use or dream about a future with 10 or 100 times the current world energy use, we must consider the environmental consequences. While many environmental problems can be avoided or at least mitigated by the careful use of technology, many are uncontrollable, like the atmospheric buildup of carbon dioxide. As we become more conscious of these adverse consequences, we may want to slow the growth in energy use.

Any proposed solution to the energy problem must contain several facets.[13] First, the increase in world population must be slowed and soon stopped. Each increase in population expands the demand for energy proportionally and makes it more difficult to bring about a solution. Population growth also makes it more

(*Continued on page 130*)

[10]L. Sagan, "Health Costs Associated with the Mining, Transport, and Combustion of Coal in the Steam Electric Industry," *Nature,* vol. 250 (1974), pp. 107-11. G. Dials and E. Moore, "The Cost of Coal," *Environment,* vol. 16, no. 7 (1974), pp. 14-24; and National Academy of Sciences, *Coal as an Energy Resource,* 1977.

[11]Lave and L. Freeberg, "Health Effects of Electricity Generation from Coal, Oil and Nuclear Fuel," *Nuclear Safety,* vol. 14, no. 5 (1973), pp. 409-28; and L. Sagan, "Human Costs of Nuclear Power," *Science,* vol. 177 (1972), pp. 487-93.

[12]Lave and E. Seskin, *Air Pollution and Human Health* (Baltimore: Johns Hopkins University Press, 1977).

[13]National Academy of Sciences: *Coal as an Energy Resource,* 1977; *Risk Panel Report,* 1978; *Supply Panel Report,* 1978, *Solar Resource Group Report,* 1978; *Demand Panel Report,* 1978; *Synthesis Panel Report,* 1978.

Lester B. Lave is head of the Department of Economics with a joint appointment in the School of Urban and Public Affairs of Carnegie-Mellon University and Adjunct Professor in the Graduate School of Public Health of the University of Pittsburgh. He has been a member of the Committee on the Benefits and Costs of Automobile Emissions and the Panel on Health Effects of the Committee on Mineral Resources and the Environment of the National Academy of Sciences. He has also served as chairman of the Synthesis/Modeling Panel of the Committee on Nuclear and Alternative Energy Systems of the National Academy of Sciences.

"Only by understanding the complex relationships among domestic production, consumption and imports can the current energy debate be transformed into an orderly assessment of future directions."

U.S. Energy Demand and Supply

BY ROBERT W. RYCROFT

Compton Visiting Fellow, Woodrow Wilson School of Public and International Affairs, Princeton University

IN the four years since the oil embargo, the global "energy crisis" has generated more than its fair share of heated debate. Nowhere has the dialogue been more visceral than in the United States, where attempts to "explain" the energy problem have ranged from projections of the physical exhaustion of mineral resources to allegations of conspiracies by the oil companies, the federal government, or the petroleum producing countries.[1]

Unfortunately, this confusion has been reflected in our attempts to formulate and implement national responses to energy issues. President Richard Nixon's administration and Congress, badly unprepared for the 1973 boycott, were overwhelmed by the fuel shortages of 1974. Years of apathy and drift suddenly gave way to near panic and "scapegoat politics." Under these circumstances, no national consensus on energy policy could be established. Project Independence, designed to achieve energy self-sufficiency by 1980, was a hastily constructed, unrealistic program that was doomed to failure from the moment it was promulgated.

Moreover, the federal organizational response mirrored the complexity of the energy crisis itself: new agencies like the Federal Energy Administration were rapidly assembled and thrown into the breach. For over two years this parochial, fragmented framework survived amid a bewildering array of technological, economic, environmental and institutional uncertainties. The creation of a Cabinet-level Department of Energy and President Jimmy Carter's formulation of a National Energy Plan is the first comprehensive effort to bring order out of this chaos. But the fate of the National Energy Plan dramatically illustrates the dysfunctional nature of energy polemics. Submitted to Congress in April, 1977, the plan provided a convenient target for every vested interest in the country. Eight months of haggling over such issues as whether to "plowback" energy tax revenues to the oil industry or rebate them to the public left the entire plan in shambles.[2]

Many of the plan's difficulties can be traced to the administration's inability to cut through the rhetoric and to communicate to the American people the true nature of the energy problem. In short, the Carter "energy crusade" has not been able to break the public indifference toward one central fact: the demand for energy in the United States is now outstripping domestic supplies, which are heavily based on vanishing deposits or depletable resources. That is:

> The first development leading to the crisis was the evolution of an energy system in which demand was destined to outstrip domestic supply. Energy consumption grew at a rate of 3.5 percent per year from 1950 to 1965, meaning that consumption would double every twenty years. From 1965 to 1973 the annual growth rate increased to 4.5 percent, or a doubling time of just sixteen years. But the major sources of this energy, crude oil and natural gas, are like oxygen in a spaceship: finite in amount, and slow to be replaced through natural processes. It would be impossible for them to support such a progressive rise in consumption indefinitely.[3]

CURRENT ENERGY DEMAND AND SUPPLY

The United States produced about 30 million barrels per day of oil equivalent (MBDOE) during 1976, the last year for which complete data are available. This represented a slight drop (0.4 percent) from the 1975 level, but considerably less of a decrease than the 1.7 percent annual production decline for the period 1973-1975. Higher outputs of coal and nuclear power only partially offset lower oil, natural gas and hydroelectric production rates. Most troublesome was the continued downward trend in domestic crude oil supply; crude

[1] See Richard L. Gordon, "Mythology and Reality in Energy Policy," *Energy Policy*, vol. 2 (September, 1974), pp. 189-203; and Richard B. Mancke, "Petroleum Conspiracy: A Costly Myth," *Public Policy*, vol. 12 (Winter, 1974), pp. 1-13.

[2] Richard Corrigan, "Lobbyists Are Putting the Blitz on Carter's Energy Program," *National Journal*, vol. 9 (November 26, 1977), pp. 1836-1840.

[3] Don E. Kash et al., *Our Energy Future: The Role of Research, Development, and Demonstration in Reaching a National Consensus on Energy Supply* (Norman, Okla.: University of Oklahoma Press, 1976), p. 3.

outputs were off 2.8 percent in 1976 (compared with a 4.7 percent per year decline during the previous two years). Natural gas production fell 1.3 percent, but this was a significant improvement over the 5.6 percent rate of decline since 1973. Hydroelectric power generation was 4.3 percent lower than the previous year. On the other hand, coal enjoyed a banner year in 1976, with production up 2.6 percent over 1975 outputs. And nuclear electric power generation continued its dramatic upward trend, rising 10.7 percent in 1976.[4] Incomplete data from the first seven months of 1977 suggest few changes in these supply patterns. Total production for the period January-July, 1977, climbed 0.5 percent, with increases in nuclear power, coal and natural gas paving the way.

American energy consumption in 1976 was approximately 37 MBDOE, or one-third of the world's production. This was an increase of 4.9 percent over 1975 and only slightly below the 1973 record. In effect, this escalation of energy consumption represents a return to the rapid demand growth pattern characteristic of the 1960's and early 1970's, after two years in which consumption actually declined at an average rate of 2.5 percent. With the exception of hydroelectric power, which was down 5.0 percent from 1975, the inputs of every major energy source increased in 1976: nuclear power consumption was up 10.8 percent, oil use was 7.0 percent higher; coal demand increased 6.5 percent; and natural gas consumption was up 1.5 percent.

During 1976, national energy consumption grew at similar rates for the three sectors of the economy. Industrial use had the largest growth rate, 5.9 percent; but residential/commercial demand increased 4.3 percent, and transportation consumption grew by 4.9 percent over 1975 levels. As a result of these trends, in 1976 the industrial and residential/commercial sectors each consumed 37 percent of the total United States energy consumed, and transportation accounted for the remaining 26 percent. According to the available 1977 data, there is no end in sight for demand growth of this magnitude: consumption for the first seven months of 1977 was 4.8 percent higher than 1976.[5]

Since 1947, fossil fuel imports have filled the United States supply-demand gap. In 1976, with consumption exceeding production by seven MBDOE, energy imports set a record high of 8.3 MBDOE (for the most part, United States coal exports account for the difference). Total fuel imports were 19.5 percent higher than in 1975; crude oil, refined petroleum products, and natural gas imports increased by 28.8, 4.5, and 1.8 percent, respectively. By the end of 1976, oil imports accounted for over 20 percent of all energy consumption and 42 percent of all oil consumption. And in early 1977 the situation worsened—for several months the United States imported over half its supply of petroleum.

TABLE 1: U.S. Energy Supply, Demand and Reserves, 1976

Energy Resource	Percent of 1976 Supply	Percent of 1976 Demand[a]	Percent of 1976 Reserves[b]
Domestic Oil	32.1	27.0	4
Natural Gas	34.1	27.3	5
Coal	25.2	18.6	68
Hydroelectric/ Geothermal	5.3	4.2	8
Nuclear Power	3.3	2.7	9

Notes: a Imported oil accounted for 20.2 percent of demand.
b Oil shale accounted for 6 percent of reserves.

Sources: Federal Energy Administration, *1976 National Energy Outlook* (Washington, D.C.: Government Printing Office, 1976), p. xxii; Federal Energy Administration, *Monthly Energy Review,* March, 1977, p. 1; and Central Intelligence Agency, *The International Energy Situation: Outlook to 1985* (Washington, D.C.: Central Intelligence Agency, 1977), p. 10.

TABLE 2: Major Sources of U.S. Oil Imports, 1973-1976

Source of Imports	Percent of 1973 Imports	Percent of 1976 Imports
Western Hemisphere		
Canada	21.2	9.4
Venezuela	18.1	8.5
Caribbean	23.0	17.7
Others	1.6	2.3
Total	63.9	37.9
Eastern Hemisphere		
Saudi Arabia	7.8	16.8
Other Middle East	5.4	7.6
Nigeria	7.3	13.7
Other African	2.6	13.6
Indonesia	3.4	7.6
Others	9.6	2.8
Total	36.1	62.1

Source: Frank N. Ikard, "America's Energy Needs," *National Journal,* vol. 9 (March 19, 1977), p. 447.

Two elements of the current energy situation create fundamental problems. First, and most significantly, the nation depends on its least abundant energy resources to provide most of its energy needs. Table 1 shows that while domestic oil and natural gas accounted for almost two-thirds of supply and over half of demand in 1976, these two resources together totaled only nine percent of United States reserves. Second, increasing reliance on oil imports has left the nation exposed to any future supply interruptions from abroad. This is particularly the case today since, as Table 2 demonstrates, over the last three years there has been a dramatic shift away from relatively reliable Western Hemisphere sources of oil imports to less "secure" Eastern Hemisphere sources. Taken together, these two factors have led to the current United States energy dilemma and to a major crossroads in national energy

[4]Federal Energy Administration, *Monthly Energy Review,* February, 1977, pp. 1-2.
[5]*Ibid.*, p. 1.

TABLE 3: Estimates of Short-Term Domestic Energy Demand and Supply

	1985 Demand		1985 Supply	
	High	Low	High	Low
Central Intelligence Agency	61.9	48.2	37.1	34.7
National Energy Plan	48.3	45.2	40.0	37.1
Organization for Economic Cooperation and Development	47.2	45.7	42.1	38.2
Workshop on Alternative Energy Strategies	53.4	40.4	43.0	30.5

Sources: Central Intelligence Agency, *The International Energy Situation: Outlook to 1985* (Washington, D.C.: Central Intelligence Agency, 1977), pp. 7-15; Executive Office of the President, *The National Energy Plan* (Washington, D.C.: Government Printing Office, 1977), pp. 95-96; Organization for Economic Cooperation and Development, *World Energy Outlook* (Paris, France: Organization for Economic Cooperation and Development, 1977), pp. 36-45. Paul S. Basile, ed., *Energy Demand Studies: Major Consuming Countries* (First Technical Report of the Workshop on Alternative Energy Strategies) (Cambridge, Mass.: The MIT Press, 1976), pp. 480-508; and William F. Martin, ed., *Energy Supply to the Year 2000* (Second Technical Report of the Workshop on Alternative Energy Strategies) (Cambridge, Mass.: The MIT Press, 1977), pp. 341-370.

policy. According to the authors of the National Energy Plan:

> The United States is at a turning point. It can choose, through piecemeal programs and policies, to continue the current state of drift. That course would require no hard decisions, no immediate sacrifices, and no adjustment to the new energy realities. That course may, for the moment, seem attractive. But, with every passing day, the United States falls farther behind in solving its energy problems. Consequently, its economic and foreign policy position weakens, its options dwindle, and the ultimate transition to scarce oil supplies and much higher oil prices becomes more difficult.[6]

SUPPLY-DEMAND STRATEGIES

The Energy Policy Project of the Ford Foundation made the first comprehensive attempt to specify the range of energy choices available to the United States. Its landmark study, *A Time To Choose,* altered the entire energy debate by positing three alternative energy futures: "historical growth"; "technical fix"; and "zero energy growth."[7] In the historical growth future, energy demand would continue to rise at the average rate of the period between 1950 and 1970 (about 3.5 percent annually) while energy supply policy would simply try to match this rapid increase in consumption. Essentially, this alternative would emphasize "business as usual," but with a more vigorous energy research effort, expanded domestic resource development, and continued reliance on imports. The technical fix future would reduce demand (about 4 percent below historical growth) by improving efficiency in energy consumption activities. That is, scientific and engineering expertise would be used to develop energy saving technologies to improve such end-uses as auto fuel economy and power plant processing efficiency. By reducing demand growth, this alternative would allow greater flexibility in energy supply policy; environmentally controversial sources and other high-risk developments could be delayed or expanded at a slower rate. The most controversial option, zero energy growth, would include all the technical fix efficiency measures. But in this strategy there would be an attempt to redirect economic growth away from energy-intensive activities (manufacturing, for example) and toward purposes which consume less energy (like public services). Ultimately, energy demand growth would be reduced to zero, allowing for tremendous flexibility in the choice of supply sources. Under these circumstances, large energy production technologies could be deemphasized and smaller scale, environmentally benign supply systems could be implemented.

The Ford Foundation triggered an avalanche of analyses of future United States supply-demand strategies. But by far the most influential assessment has come from Amory Lovins. In a *Foreign Affairs* article that is already a classic, Lovins outlined and compared two courses that the United States might follow over the next 50 years: the "hard" and the "soft" paths.[8] For Lovins, the hard path closely parallels historical growth. It emphasizes the rapid deployment of large, centralized technologies to increase supplies of all forms of energy and especially supplies of electricity. Energy demand growth modification receives very little attention in the hard path. The soft path, on the other hand, combines technical fix responses with the deployment of soft, or "appropriate" technologies (e.g., technologies which are diverse, flexible, matched in scale and quality to end-use, and based on renewable sources of energy). The soft path would eventually lead to minimal, zero, or even negative energy demand growth.

These two studies have, in effect, established the boundaries for any consideration of future energy demand and supply. The following summary of short-, mid-, and long-term supply-demand problems and prospects views the future in terms of a continuum of possible responses, bracketed by a hard path/historical growth option at one end and a soft path/

[6]Executive Office of the President, *The National Energy Plan* (Washington, D.C.: Government Printing Office, 1977), p. xiv.

[7]Energy Policy Project of the Ford Foundation, *A Time To Choose: America's Energy Future* (Cambridge, Mass.: Ballinger, 1974), pp. 19-112.

[8]Amory B. Lovins, "Energy Strategy: The Road Not Taken?" *Foreign Affairs,* vol. 55 (October, 1976), pp. 65-96.

technical fix/zero energy growth alternative at the other.

IN THE SHORT-TERM

The short-term is the most crucial period for future United States energy policy because the national need for energy is immediate and because many of the short-term opportunities and constraints on supply and demand significantly affect supply and demand later. Until 1985, the major energy demand problem is to reduce United States consumption of energy in general and oil in particular. Although energy conservation policies could, by conservative estimates, reduce consumption by 10-15 percent over the next decade, there are substantial obstacles to those measures (such as car-pooling) that would require changes in life-styles. Energy efficiency programs oriented toward consumption reduction techniques like residential weatherization or industrial cogeneration face fewer institutional and behavioral barriers.[9]

Recent projections of short-term United States energy demands range from 40.4 to 61.9 MBDOE, as illustrated in Table 3. The lower demand estimates represent an annual energy consumption growth rate of only about one percent per year until 1985, while the higher projections reflect historical growth rates of over four percent annually. Most projections, however, place 1985 demand somewhere in the neighborhood of 45-48 MBDOE, a growth rate of about three percent per year. Much of this increased consumption would be in the industrial sector; industries like petrochemicals and iron and steel are expected to be high demand growth areas for the short-term. According to most estimates, residential/commercial and transportation consumption will increase at much slower rates than in the past. Rapid expansion of electricity consumption will probably account for much of the industrial and residential demand growth.

The primary short-term energy supply problem is to respond to the immediate need to increase the domestic production of conventional sources while simultaneously guaranteeing that the development of nonconventional sources is not neglected. There is a very real danger that efforts to encourage coal production and nuclear power generation might retard the expansion of the use of renewable resources like geothermal and solar energy, which are essential components of later time frames. The most serious obstacles to increased energy supplies in the short-term are sociopolitical, and not technical. Neither coal nor nuclear power can claim a major share of the supply picture before 1985 unless chronic uncertainties about their environmental acceptability can be resolved. And major new discoveries of oil or natural gas, while possible, must be considered unlikely. Thus, even with substantial price increases, most forecasts of short-term supply are not optimistic. According to the estimates summarized in Table 3, 1985 domestic energy supply could range from 30.5 to 43.0 MBDOE. The lower projections usually assume some delays in conventional resource development, while the higher estimates are based on a "vigorous" national response to shortages (through decontrol of oil and gas prices, extensive federal leasing of coal lands, and so on). The most common assessment of short-term supply potential is in the range of 37-38 MBDOE, largely a function of moderately higher coal and nuclear power generation.

Energy imports in the short term could, with historical demand growth rates, reach 25 MBDOE. But a more likely possibility would see the United States importing about 12-14 MBDOE, still a substantial burden on the economy. In this area, much depends on the future supply capabilities of the Organization of Petroleum Exporting Countries (OPEC), and particularly on the productive capacity and political orientation of Saudi Arabia.[10]

IN THE MID-TERM

The period between 1985 and 2000 is usually characterized as the "bridge" between reliance on finite, conventional sources and the changeover to renewable, nonconventional sources of energy. While projections beyond 1985 are far less certain than projections for the short term, it is possible to make some generalizations regarding the characteristics of supply and demand between 1985 and 2000.

Most certainly, the mid-term United States supply system will have to deal with the shortfall between desired oil imports and the maximum available foreign oil exports (perhaps as much as 25 percent over available supplies). While total United States supply and demand may differ by only a small percentage by the year 2000, this gap between the supply and demand of *preferred* fuels is the key. Obviously, coal and nuclear power will play a large role as the end of the "oil era"

(*Continued on page 130*)

[9]See Monte Canfield, Jr., and Adam E. Sieminski, "If You're So Smart, Why Ain't You Rich—An Analysis of Impediments to Implementing Energy Conservation in the United States," *Public Administration Review,* vol. 35 (July/August, 1975), pp. 322-327.

[10]See Central Intelligence Agency, *The International Energy Situation: Outlook to 1985* (Washington, D.C.: Central Intelligence Agency, 1977).

Robert W. Rycroft, a Compton Visiting Fellow in the Center of International Studies, Woodrow Wilson School of Public and International Affairs, Princeton University, served as a research assistant and later as a research fellow at the Science and Public Policy Program of the University of Oklahoma. For over four years, he has been primarily involved in applied energy policy research, and is coauthor of *Our Energy Future: The Role of Research, Development, and Demonstration in Reaching a National Consensus on Energy Supply* (Norman, Okla.: University of Oklahoma Press, 1976).

"In the long run, all the OECD members will develop their energy policies within the context of a continuing and constructive dialogue with the International Energy Agency. This is not to argue that the energy problems of the various regions will become the same (obviously, Japan's will remain acute), but that it is increasingly senseless to look at the search for technological solutions on a national or even regional basis. Technology diffuses so rapidly these days that a strictly national approach is self-defeating."

European and Japanese Energy Policies

BY LOUIS TURNER

Research Fellow, Royal Institute of International Affairs, London

THE more one looks at the record, the clearer the unusual nature of the United States energy experience comes over. Most other industrialized market economies (henceforward, the Organization for Economic Cooperation and Development, "OECD nations") have been far more dependent on energy imports, far less profligate in energy usage and far more sensitive to the international political realities of the energy trade. In contrast to the United States, most of these countries entered the 1970's with relatively centralized political structures that were able to respond speedily to the post-1973 energy environment. Obviously, not all these governments have moved with equal effectiveness. Blunders and wishful thinking have marred the picture. But in general, while the United States is still trying to establish a coherent energy policy, the governments of Europe and Japan are modifying policies they adopted in the immediate post-1973 period. One can almost say that they are generally moving on to "Mark 2" energy policies, characterized by greater realism about what is actually achievable in this field than was typical of the 1974-1975 era.

Table 1 gives some idea of the wide variations in the pre-crisis patterns of energy supply and usage in Japan and the various European countries.[1] Norway, Austria, Iceland, Switzerland, Sweden and Portugal have healthy supplies of hydroelectric power; the British and Germans have sizable coal industries; the Dutch, British and Italians are strong in natural gas; the Norwegians and British have become major oil producers over the last couple of years as North Sea fields have come on stream.[2] At the same time, Table 2 illustrates the striking variations in patterns of energy consumption among the leading OECD nations. The non-Americans are noticeably less profligate than the United States with energy in the transportation sector, while the Japanese have a consumption pattern heavily skewed toward industrial usage and away from domestic usage (which is hardly surprising, given this country's poor housing conditions and strong emphasis on industrialization).

One measurement—the degree of dependence on energy imports—stands out among all these national peculiarities as being of the utmost importance. It is this that separates the still relatively energy self-sufficient United States from most of the rest of the OECD world. Japan is peculiarly vulnerable in this regard. The Europeans fall somewhere between the United States and Japan, though there are interesting intra-European differences between countries like the United Kingdom, the Netherlands, Norway and West Germany, which are all more than 50 percent self-sufficient in energy, and Italy, France and Belgium, which do not even supply 25 percent of their own needs. This polarization within Europe is increasing, as North Sea oil and gas benefit the northern tier of European countries while adding nothing to the indigenous supplies of Mediterranean states.[3]

With the growing uncompetitiveness of coal during the 1950's and 1960's, Japanese and European governments felt increasingly free to rest their economies on cheap and seemingly safe supplies of Middle Eastern and North African oil.[4] Oil demand in Japan grew at over 18 percent per annum during the 1960's and early 1970's (see Table 1), and demand grew almost that rapidly in European economies like those of France, Germany and Italy. Of course, such growth rates in oil and energy demand could not continue forever. But

[1] I use "European" to refer to non-Communist European countries. I am not restricting myself to the nine countries in the European Communities (EC).

[2] See also Table 7 in Guy de Carmoy, *Energy for Europe* (Washington, D.C.: American Enterprise Institute, 1977), p. 39.

[3] The British should be self-sufficient (net) in energy from around 1980; Norway has been in this position since 1975.

[4] This complacency is best seen in the influential Robinson Report, *Towards a New Energy Pattern in Europe* (Paris: O.E.E.C., 1960).

TABLE 1: Indigenous Energy Production Compared to Consumption in OECD Countries in 1972 and Annual Growth Rates in Oil and Energy Demand 1960-1972*

Country	Coal	Oil	Gas	Hydro Electricity	Nuclear Electricity	Total Energy Self-Sufficiency	Annual Growth in 1960-1972 Demand for: Oil	Energy
Canada	77	115	178	76	3	120	5.3%	5.8%
Australia	171	56	100	20	–	108	7.6	5.1
USA	112	68	97	14	3	86	4.2	4.0
Norway	36	23	–	107	–	72	6.9	5.6
Netherlands	63	6	171	–	1	70	9.8	9.5
UK	98	2	97	2	11	51	6.8	1.2
W. Germany	115	7	64	5	3	50	12.6	4.4
New Zealand	102	3	100	72	–	42	6.4	5.9
Turkey	100	35	–	29	–	31	15.4	13.6
Austria	25	25	55	59	–	30	11.3	4.7
Iceland	–	–	–	96	–	24	3.4	5.0
France	69	1	54	30	9	23	14.1	5.7
Greece	85	–	–	20	–	21	10.5	10.9
Spain	85	–	–	49	7	21	15.7	8.5
Switzerland	–	–	–	77	14	21	11.2	6.2
Sweden	–	–	–	75	2	17	6.9	5.8
Belgium**	65	–	–	2	–	16	11.9*	5.1*
Portugal	44	–	–	80	–	16	10.8	9.0
Italy	5	1	93	33	3	15	12.4	8.5
Japan	32	–	68	20	2	10	18.7	11.1
Finland	–	–	–	38	–	7	13.5	10.7
Ireland	8	–	–	10	–	2	11.2	3.9
Luxembourg**	–	–	–	42	–	2	11.9*	5.1*
Denmark	–	–	–	–	–	–	11.8	7.2

*The figures for coal, oil and gas are the ratio of the indigenous supply of the fuel to total indigenous consumption of that fuel. The figure for hydro- and nuclear electricity is the ratio of the electricity they supply to total electricity consumed. The figure for "total energy self sufficiency" is the ratio of total indigenous supply to total primary energy.

**These figures are for Belgium and Luxembourg combined.

Sources: Energy Prospects to 1985, Vol. 1 (Paris: OECD, 1974), p. 184. The growth rates for oil and energy demand were generated from tables in *Our Petroleum* (London: British Petroleum, 1977), pp. 568, 573.

TABLE 2: Energy Consumption in Major Countries by Sector (1975)

Country	Total (10^{10} kcal)	Energy	Transport	Industry	Household/ Commercial
US	1,707,014	12.0%	23.7%	31.4%	32.9%
UK	196,706	11.7	15.3	34.9	38.2
West Germany	248,153	10.0	14.1	39.2	36.8
France	162,856	9.5	17.5	36.4	36.6
Italy	131,098	9.2	15.4	43.9	31.5
Japan	309,141	8.4	15.4	50.4	25.7

Source: Japan's Energy Situation (Tokyo: Foreign Press Center, October, 1977), p. 7, citing OECD sources.

there were forces at work that blinded these countries to their dependence on one source of fossil fuel and one particularly volatile part of the world. There were governments like those of the United Kingdom, the Netherlands and France, which worked closely with their "own" international oil companies, British Petroleum (BP), Royal Dutch-Shell and the Compagnie Française des Petroles (CFP); they believed that the oil majors would continue to keep the oil producing governments in check. In addition, the discovery of important new reserves of oil in North Africa during the early 1960's seemed to reduce the risk that the Arab oil producers would ever unite against the importing countries. Finally, comfort was taken from OPEC's

failure to improve the lot of the oil producers in the face of the buyers' market of the 1960's.[5]

In contrast to this general air of complacency, some governments were slowly becoming aware of the risks of overdependence on oil imports. The French, who had faced this problem in World War I, were resigned by the 1950's and 1960's to the need for oil imports, but they continued to try to maximize the proportion that came from French-controlled areas.[6] Germany and Japan, which had no significant corporate presence in the international oil industry, spent the late 1960's trying to create or strengthen their own exploration companies, and both set targets for the proportion of oil imports they would like to see coming from nationally controlled sources.[7] The Europeans in general could not ignore the temporary disruption of oil flows that resulted from the 1956 and 1967 Arab-Israeli wars, and there was thus some contingency planning for similar emergencies within what became the OECD in the early 1960's.[8]

In general, though, the OECD nations' worries focused primarily on considerations of security and economic nationalism (why should they depend on the Anglo-Dutch-American oil majors?). What had not seeped into government consciousness until the early 1970's was the fact that the era of cheap oil was about to end. Thus there had been virtually no forward planning before 1973, when the world was suddenly pitchforked into an era of expensive energy.

SECURITY OF SUPPLY

Events since October, 1973, have made it plain that energy policies should be concerned not only with developing indigenous energy sources but also with improving the security of needed imports. Since Japan and most West European countries entered this period with imports of Middle Eastern oil that could not be totally eliminated, even in the long run, it was inevitable that they all gave strategies to increase the security of their supplies high priority.

In the beginning, there was a great deal of tension between two different approaches to the security issue. Many countries were initially attracted by a *sauve-qui-peut* strategy, trying to secure their supplies of Middle Eastern crude by direct government-to-government deals or by politically distancing themselves from the United States and the Israeli cause. In the case of Japan, this "petro-diplomacy" started before the Yom Kippur war.[9] French policies toward the Arab world in the 1960's and early 1970's had a similar tinge of calculated economic self-interest.

One might perhaps say the same for the European Communities' (EC) shift away from the Israeli cause immediately after the Arab-Israeli hostilities.[10] Throughout early 1974, missions from Japan, France, Britain, Italy and Germany crisscrossed the oil-producing world, signing a series of deals for small quantities of oil. However, it slowly became clear that the advantages of such deals were relatively small compared to the disadvantages (the inordinate amount of diplomatic time involved and the ease of miscalculating prices when barter was involved).[11]

By 1977, this particular strategy had become more measured. The emphasis moved away from direct intergovernmental deals for oil toward more general forms of cooperation with the oil-producing world. Thus the Japanese government worked hard at winning its companies a leading role in the industrialization of producer states like Iran, Iraq and, with less initial success, Saudi Arabia. The EC brushed aside United States opposition and opened a formal dialogue with the Arab world (the "Euro-Arab dialogue") aimed at identifying areas in which the EC could aid Arab economic aspirations. Currently, most of the concern in this dialogue turns on the extent to which Arab and European plans in the oil-refining and petrochemical spheres can be made complementary. In pursuing such initiatives, both the Europeans and the Japanese are assuming that any action that increases their two-way ties with the Middle Eastern oil producers will win the goodwill of Middle Eastern states and thus will increase the security of future oil supplies.[12]

However, if appealing to the self-interest of the producing world was one strategy for improving the security of imported energy supplies, there was a second, more defensive strategy that the OECD nations pursued—and Japan and the Europeans played their part in this as well. This particular strand of energy policy was built round the International Energy Agency (IEA), which sprang from an initiative of United States

[5] I analyze the reasons for this confidence in Chapter 3 of my forthcoming book, *The Oil Companies in the International System* (London/New York: Allen & Unwin, 1978).

[6] Horst Mendershausen, *Coping with the Oil Crisis* (Baltimore: Resources for the Future, 1976), pp. 26-31.

[7] For Japanese policies see: Yoshi Tsurumi, "Japan," *Daedalus*, Fall, 1975, pp. 113-127 and Masao Sakisaka, "Japan's Long-Term Vulnerabilities" in J. C. Hurewitz, ed., *Oil, the Arab-Israel Dispute and the Industrial World* (Boulder, Colorado: Westview Press, 1976), pp. 52-64. For Germany, see Horst Mendershausen, *op. cit.*, pp. 23-6.

[8] N. J. D. Lucas, *Energy and the European Communities* (London: Europa Publications, 1977), pp. 11, 49 and Turner, *op. cit.*, Chapter 3.

[9] Kazushige Hirasawa, "Japan's Tilting Neutrality" in Hurewitz, *op. cit.*, pp. 138-40; Yoshi Tsurumi, *The Japanese Are Coming* (Cambridge, Mass: Ballinger, 1976), pp. 278-9; Terutomo Ozawa, "Japan's Resource Dependence and Overseas Investment," *Journal of World Trade Law*, January-February, 1977, pp. 52-73.

[10] Hans Maull, "The Strategy of Avoidance: Europe's Middle East Policies after the October War," in Hurewitz, *op. cit.*, pp. 110-137.

[11] Turner, *op. cit.*, Chapter 8.

[12] Maull, *op. cit.*, pp. 130-2; Louis Turner and James Bedore, "Saudi and Iranian Petrochemicals and Oil Refining: Trade Warfare in the 1980's?" *International Affairs*, October, 1977, p. 583.

Secretary of State Henry Kissinger, was created in 1974, is now part of the OECD and counts among its members all the OECD grouping, bar France.[13]

The IEA's initial goal was to help the OECD world avoid (in any future disruption of oil supplies) the muddle and panic of the autumn of 1973. To this end, the IEA set its members goals for the increase of their oil stockpiles and created an emergency allocation scheme that laid down the rules for how oil shortages and supplies in any future supply crisis should be shared among the OECD nations. Most European countries have long had some form of oil stockpiling program, so IEA goals in this area have not proved particularly controversial. The emergency allocation scheme was a bit more difficult, since the French had opted out of the IEA (they felt it was too concerned with confronting the oil-producers) and pushed for a scheme run by the EC in Brussels. After a certain amount of intra-European diplomacy, in late 1977 the EC produced its own scheme, which was designed to be compatible with the IEA's version, but went a step further by including fuels other than oil in its calculations.[14]

In contrast, the Japanese have had more difficulty with the stockpiling provisions, since they did not have any official oil stockpiles before joining the IEA and, therefore, have had to move very rapidly in comparison with most European states. In addition, the dominance of oil in the Japanese economy means that Japan's ultimate stockpiles will be larger (and thus more expensive) than those needed in Europe. However, the necessary law was enacted in 1975, and Japan is committed to the IEA goal of having a 90-day reserve by 1979. The most difficult problem she faces is finding locations for the necessary storage tanks.[15]

Thanks to the falling real price of oil, no OECD country entered the 1970's with a coherent energy policy. Hence, the events of late 1973 and 1974 meant that most policy-makers charged with devising energy programs were working in a policy vacuum. As a result, most of them badly overestimated the speed with which conservation measures could cut into energy demand and with which alternative sources of energy could be brought on stream. Most turned instinctively to accelerated nuclear power programs as the easiest way out of the energy dilemma, only to find that they had underestimated both the technological complexity of the industry and the resulting grass-roots opposition.

For a country where the government-company relationship has been so close and where oil imports are so crucial, the Japanese have been surprisingly tentative in establishing a realistic program. This stems in part from a failure to create a ministry specifically charged with energy policy. Instead, the Ministry of International Trade and Industry (MITI) took over this role but delegated most of the initial analysis of supply and demand to an advisory body called the Overall Energy Council.[16] It took this body until August, 1975, to publish projections for Japan's 1985 energy demand and supply—but these remained little more than pious and unrealistic wishes. There were some positive points; for instance, the report suggested that Japan should diversify her energy supplies by increasing imports of non-polluting liquified methane (LNG), much of which could come from Asian sources; coal production should no longer be allowed to decline. On the other hand, there was an unrealistic faith in the impact of nuclear energy by 1985. In 1972, Japan had a 1.8 GW* nuclear capacity (0.7 percent of her energy demand). The report assumed that there could be 49 GW capacity in place by 1985 (this was a reduction in previous government estimates that 60 GW could be available by that date). Thus nuclear energy would have to supply about 10 percent of the country's energy needs in 1985.

These projections were soon proved hopelessly optimistic. Slower economic growth led to the cutting back of electricity generation plans and hence the need for nuclear plants. But there was also strong anti-nuclear pressures from groups that are particularly strong on such a crowded, heavily industrialized island with memories of Hiroshima and Nagasaki. The result was that, by 1977, nuclear starts were running at around 2 per year, when 6 per year would have been needed to meet the goals expressed in the 1975 report.

What surprised outside observers was how slowly the Japanese government responded to the fact that these semi-official goals were not being met. Prime Minister Takeo Fukuda's attempts to create a unified energy ministry foundered in the face of strong MITI opposition, and Japanese policy is still represented by the modified projections of the Overall Energy Council. This body produced a further analysis in July, 1977, downgrading nuclear potential to between 26 and 33 GW in 1985 (between 5.4 and 7.4 percent of the country's energy supplies).[17]

Where does this leave Japanese policies? On the one hand, the fact that so much of Japan's energy usage is in the industrial sector means that conservation measures have been easy to implement, since companies are more responsive to government direction than the man in the street. Attempts to find oil and gas offshore of

*A gigawatt (GW) equals 1,000 megawatts.

[13]Ulf Lantzke, "The OECD and Its International Energy Agency," *Daedalus*, Fall, 1975, pp. 217-227; Wilfrid L. Kohl, "The International Energy Agency: The Political Context," in Hurewitz, *op. cit.*, pp. 246-257; Ann-Margaret Walton, "Atlantic Bargaining over Energy," *International Affairs*, April, 1976, pp. 180-96.

[14]*Petroleum Intelligence Weekly*, October 31, 1977, pp. 3-4.

[15]Foreign Press Center (Tokyo), *Japan's Energy Situation* (Tokyo: Foreign Press Center, 1977), pp. 20-2.

[16]*Petroleum Economist*, October, 1974, pp. 369-71; September, 1975, pp. 335-36; August, 1976, pp. 292-95; March, 1977, pp. 88-9; April, 1977, p. 144.

[17]Foreign Press Center, *op. cit.*, p. 27.

Japan have had limited success, though the years since 1974 have seen the settling of some of the worst boundary disputes (as with South Korea) so that offshore exploration will be able to gather speed. On the other hand, there has been very little progress in finding ways of cutting back Japan's dependence on imported oil. The nuclear option is slow in its effects, and every increase in the imports of other fuels like LNG or coal runs into political problems about the siting of import terminals. The government has, however, improved its relations with the Middle Eastern oil producers like Iran and Iraq and has initiated oil imports from China, thus diversifying Japan's suppliers (although there are quality problems with this oil). Perhaps the greatest potential for increasing Japan's energy supply may lie in helping the Soviet Union develop its Siberian reserves. Plans for joint ventures have been shelved because of Japanese worries about Chinese susceptibilities—but the geopolitical logic of matching eastern Soviet reserves to the markets and technological ambition of Japan remains convincing.[18] Finally, it should be noted that most of Japan's problems stem from the poverty of her mineral resources. She has acted relatively fast in areas like pollution control, energy conservation and the creation of oil stockpiles. If Japan remains nearly 90 percent dependent on imported energy for much of the 1980's, this will be largely the fault of geological history.

THE EUROPEANS

In an article this length, one cannot give full treatment to the complexities of EC and wider European energy policies. But, at the risk of oversimplification, one can say that the Europeans have generally started with a relatively economical usage of energy (at least by North American standards); that the countries bounding the North Sea have proved effective in overseeing the smooth and expeditious exploration of this area's oil and gas reserves; that most countries fell into the trap of overestimating the potential of nuclear power; that it has been the activities of national governments that have been most important—not those of the EC Commission in Brussels, which has proved virtually irrelevant to the formation of effective energy policies in Europe; that the most effective international institution based in Europe has been the International Energy Agency which, though its membership makes it more than a "European" body, has molded the policies of the EC member states far more than the EC Commission has; that the Europeans have become more heavily integrated into the economies of the Middle Eastern and North African oil producers than either the United States or Japan; and that the Euro-Arab dialogue is an unparalleled attempt to give this economic interdependence some political expression.

The big difference between Europe and other parts of the OECD world is that Europe has significant new non-nuclear energy resources that are being brought on stream sufficiently fast to assure that both the EC members and the wider OECD-Europe grouping will reach 1985 needing fewer barrels of oil from OPEC members than they do today. Obviously, it was a matter of luck that the North Sea should turn out to be an oil province whose proved reserves totaled 22.8 billion barrels at the end of 1976,[19] but one is impressed by the relatively smooth way in which median boundaries were set, licensing terms settled and environmentalist worries allayed. North Sea developments have been seriously delayed only off Denmark, where company-government relationships were handled badly from the start; and off Norway, which has restricted developments to the southern parts of her offshore area because of economic and strategic considerations.[20] The result is that indigenously produced oil and gas (much of the latter from Dutch offshore fields) supplied 13.3 percent of OECD Europe's energy needs in 1974; by 1985, there is a good chance that they will be supplying 27 percent of these needs.[21] Already the Norwegians are net exporters of energy; the British should follow suit sometime in late 1978 or early 1979.

It is a moot point how much of the credit for this relatively smooth development of the North Sea should actually be given to government policies, for one can argue that it was the escalation of oil prices by OPEC that suddenly transformed the economics of this oil province. If prices had remained at 1960's levels, few if any of the North Sea fields would have been developed; thus the price explosion of the era after 1973 has meant that a range of fields could be developed that were not otherwise expected to be commercially viable until the 1980's. On the other hand, when one looks at the difficulties the United States government has faced in

(*Continued on page 129*)

[18] Jeremy Russell, *Energy as a Factor in Soviet Foreign Policy* (Lexington: Lexington Books, 1976), pp. 155-70.

[19] *Oil and Gas Journal*, December 27, 1976, p. 104.

[20] Martin Sacter and Ian Smart, eds., *The Political Implications of North Sea Oil and Gas* (Guildford, U.K.: IPC Science and Technology Press, 1975); D. I. MacKay and G. A. MacKay, *The Political Economy of North Sea Oil* (London: Robertson, 1975).

[21] *World Energy Outlook* (Paris: OECD, 1977), pp. 46ff.

Louis Turner is a research fellow at the Royal Institute of International Affairs (Chatham House) in London. He is the author of two books on multinational companies, *Invisible Empires* (New York: Harcourt Brace Jovanovitch, 1970), *Multinational Companies and the Third World* (New York: Hill and Wang, 1973) and a forthcoming book on the oil industry, *The Oil Companies in the International System* (New York: Allen and Unwin, 1978). He is currently researching the international implications of Middle Eastern industrialization.

"The energy crisis has aggravated the chronic malaise of the nations of the developing world. It has made it more difficult for them to overcome old and new social, economic and political problems. Unless substantial funds are forthcoming from abroad, their future will remain bleak."

Oil-Poor Developing Countries

BY FERAIDOON SHAMS B.

Assistant Professor of Social Sciences, Howard University

SINCE the oil crisis of autumn, 1973, the problem of meeting the world energy requirement has assumed urgency. Incessant global demand on non-renewable energy resources, followed by inflation and the rising price of world oil, present the energy-deficient developing economies with varying degrees of uncertainty and disequilibrium.

The pre-1973 world enjoyed the benefits of inexpensive energy and a phenomenal advance in technology, whose improvement of energy efficiency coefficient was of little or no concern. Today, however, the serious implications of indiscriminate uses of energy are recognized by many oil-deficient nations.

In general, since 1900, demand for world primary energy (e.g., solid fuels, liquid fuels, primary electricity and natural gas) has been rising. From 1900 to 1960, the rate of increase in world demand for petroleum alone was almost 2.1 percent per annum. But in 1970 it increased to 5.3 percent per annum, representing a growth rate of 3.2 percent over the 1960 level. For decades, the industrialized United States and the states of West Europe have been the major consumers of oil and related energy sources. These nations have vigorously pursued an "energy-intensive" economy, consuming about two-thirds of the world's energy and raw materials. Between 1950 and 1970, the primary energy demand of the leading industrial states, with almost one-fifth of the world's population, increased by 223 percent.[1]

In the developing countries (excluding the Organization of Petroleum Exporting Countries, OPEC), which account for approximately half the world's population, energy consumption has been far below that of the developed states. As recently as 1976, the developing nations consumed about 10 percent of the world's energy, or almost 13 percent of the energy consumption of the developed market economies. The demands for energy in these states is commensurate with their overall growth rates of gross national product (GNP), growth rates in demand for energy products, income and price fluctuations.[2]

The amount of energy consumption is clearly smallest in the developing world. Furthermore, there is a significant relationship between levels of energy consumption and industrialization. In the case of developing, less developed and underdeveloped nations, the process of transition from a primarily agricultural to a primarily industrial economy has been either nonexistent or minimal. Rather, these nations have become increasingly dependent on easily imported products of advanced technologies to fit their changing needs, mostly in urban centers. In those societies that have made modest progress towards industrialization, the lessons have been disquieting, because these nations lack enough trained manpower, among other needs, to achieve meaningful industrial growth. On the economic level, the essential conditions for existence and equal access to basic resources that sustain life have in fact worsened in many of the developing countries. Most of these states lack capital resources for economic progress and growth.

If we accept a level of "high" income in non-OPEC developing countries at a per capita income of about $500 a year, then in 85 countries for which data are available over two billion persons live below that level, and 1.2 billion live in states where growth and other economic activities become almost nonexistent. During 1974, the declining rate of per capita income in the low income nations was about five percent. "For hundreds of millions of them already severely deprived, it meant hunger, illness and an erosion of hope." Compared with the people of the advanced economies, the people living in middle income developing countries, whose population was estimated to be 725 million in 1975, would also grow "relatively poorer" during the Second

[1]E. N. Tiratsoo, *Oilfields of the World* (Beaconsfield, England: Scientific Press, 1976), p. 342.

[2]Adrian Lambertini et al., *Energy and Petroleum in Non-OPEC Developing Countries 1974-1980* (World Bank Staff Working Paper No. 229, February, 1976), p. 1. With the exception of "centrally planned economies," there are some 143 non-OPEC developing countries. Of which 40 are situated in Africa, 23 are located in east and south Asia, 40 are in the Caribbean and Latin America, 4 lie in the Middle East and the remaining 24 are in Oceania. For the complete list of these countries, see *ibid.*, annex 111, pp. 1-3; also World Bank, *World Economic and Social Indicators* (Washington, D.C., Report No. 700/77/06, 1977), Sources and Notes, pp. 2-6.

TABLE 1: Income and Investment Levels 1970-1980 for Developed and Developing Countries (In 1970 dollars)

Country Group	1975 Population (in millions)	GNP 1970	Per Capita 1980	GNP Growth Rate Per Capita	Estimated Investment Per Capita p.a. Dom. Svg.	Ext. Cap. Inflow	Total
1. Low Income Countries (Under $200 per capita)	1,000	$105	$108	.2%	$14	$ 2	$16
2. Middle Income Countries (Over $200 per capita)	725	$410	$540	2.8%	$75	$10	$85
3. OECD Countries	675	$3,100	$4,000	2.6%	$850	$−15	$835

Source: Robert S. McNamara, President, World Bank Group, Address to the Board of Governors (Washington, D.C., September 1, 1975), p. 7.

Development Decade (1970-1980). See Table 1.[3]

As Table 1 indicates, in low and middle income developing nations, lack of significant economic growth, including insufficient levels of investment and capital, leads to a distressing economic outlook. It would be extremely difficult for these nations to satisfy their energy requirements without acquiring substantial loans from international financial institutions.

In 1974, the combined inland consumption of conventional sources of energy (e.g., oil, coal, primary electricity and natural gas) for all non-OPEC developing countries amounted to 8.5 million barrels a day (b/d) of oil equivalent. This figure represented an increase of 5.1 million b/d from the 1960 level. To put it differently, the total oil equivalent consumption of the commercial energy products of these states in 1974 amounted to 5.8 million b/d for oil; 1.7 million b/d for coal; 211,000 b/d for primary electricity and 69,000 b/d for natural gas. And, the indigenous production of energy over the same period was estimated at 3.3 million b/d of oil; 1.6 million b/d of coal; 311,000 b/d of primary electricity and 876,000 b/d of natural gas. In other words, the non-OPEC developing countries as a whole were almost self-sufficient in the field of coal, and met 100 percent of their demands for primary electricity. Nevertheless, their reliance on oil imports showed a marked variation.[4]

During 1974, the high income group imported slightly over one-third of their oil needs. Middle and low income groups met 50 percent and 80 percent of their oil requirements from external sources respectively. As a group, some 13 countries (high, middle and low income levels), exported 1.01 million b/d of oil in 1974. It was further estimated that their share of net oil exports would continue to increase from 64 percent in 1974 to almost 70 percent by 1980.[5]

Neither the distribution of oil nor the pattern of demand for oil are uniform for different income groups within the developing countries. The majority of these countries are heavily dependent on oil for their energy requirements, and a few others are not. In 1976, Angola, Bahrain, Bolivia, Brunei, Congo, Egypt, Malaysia, Mexico, Oman, Syria, Trinidad, and Tobago, Tunisia and Zaire were among the net exporters of petroleum, although none are members of OPEC. Other developing countries, like Brazil, Burma, Chile, Colombia, India, Israel, Pakistan, Peru and Taiwan, today produce various amounts of petroleum, which they consume.[6]

In 1975, all these developing countries produced a total of 3,560,000 b/d of oil, of which 2,533,000 b/d was obtained from onshore and the remainder from offshore sources. In 1977, crude oil production among the high income group, which consists of Argentina, Bahrain, Brazil, Brunei, Chile, Colombia, Israel, Mexico, Oman, Peru, Taiwan, Trinidad and Tunisia, is estimated to amount to 3,172,000 b/d.

Over the same period, the middle income oil-producing countries, Angola, Bolivia, Congo, Egypt and Syria, are projected to produce 960,000 b/d of oil. Burma, India, Pakistan, and Zaire, in the low income category, account for 50,000 b/d of crude oil production. By 1980, it is estimated that their combined production will reach a total of 5,254,000 b/d of raw petroleum.[7]

[3]Robert S. McNamara, President, World Bank Group, *Address to the Board of Governors* (Washington, D.C., September 1, 1975), pp. 5-8. The basic assumption of data in Table 1 was that from 1975 to 1980 there would be a significant growth of "capital flow in nominal terms, but no increase in real terms." The study also assumed that the developed economies would recover from the existing recession. In the absence of such recovery, it was projected that the growth rates of per capita income in less developed countries "would of course be lower, or the external capital requirements higher." The data included 85 developing countries which had membership in the World Bank. It excluded the Centrally Planned Economies and Organization of Petroleum Exporting Countries. *Ibid.*, p. 5.

[4]The figures are drawn from "U.N. Series J and World Bank Staff Estimates," in Adrian Lambertini, *op. cit.*, p. 3. Also consult p. 10.

[5]*Ibid.*, pp. 10 and 11.

[6]*Ibid.*, p. 11 and Annex 1, pp. 1-12.

[7]Derived from Table on "Non-OPEC Developing Countries Crude Oil Production," in *ibid.*, p. 27.

In all cases, the energy per capita consumption of high, middle, and low income groups grew to 270 kilograms of oil equivalent in 1974, an increase of only 114 kilograms from their per capita consumption of energy in 1960. From these data, it can be seen that the per capita consumption of energy in non-OPEC developing countries advanced very little. Moreover, a comparison of energy per capita consumption in the United States and other industrialized states, which fluctuates between 3,000 to 8,500 kilograms per annum, shows the relative stagnation of many developing countries in the growth of industrialization.[8]

Among the elements that tend to stimulate the demand for oil in the developing countries are its relative availability and changes in the structure of their economies. Manufacturing industries, transportation services and the increasing depletion of energy sources like firewood and vegetable wastes are generally associated with growing demands for petroleum and related products. Despite the rising price of world oil, such demands have hardly declined during the last 17 years.

From 1960 to 1974, the consumption of petroleum in the developing countries increased at an average rate of 7.5 percent per annum. Should the cost of oil remain constant, it is estimated that by the end of the present decade, the oil requirements in the developing nations would increase by one percent per annum. Rising oil prices, together with a declining trend in gross domestic products, are among the factors that will limit oil consumption in the developing countries for the balance of the 1970's.[9]

The utilization of oil as a source of energy is likely to be of considerable importance to the developing countries, in the sense that it is relatively available to them and can be transported with greater ease than coal, for example. Only in a very few countries, however, does energy derived from oil supplement to any appreciable extent other sources of energy. The development of inanimate energy (e.g., coal, oil and natural gas), is of fairly recent origin and its use until three decades ago was mostly limited to modern industrial economies of West Europe and the United States. In contrast with the developed nations, less developed countries have traditionally depended on fuelwood, waterwheels and animate energy to satisfy their energy requirements. Today, in many parts of the developing world, especially in rural areas, this pattern of energy consumption is still prevalent.[10]

The demand for oil in high income developing countries is still much greater than the demand in the low income group. With the exception of the net oil exporters, other developing countries are heavily dependent on rarer sources of energy like oil. In the high income group, diversification of energy sources has helped in recent years to lessen their rising demands for energy. Thus, consumption of oil, in comparison with other energy sources, has remained at a "fairly stable" level of 78 percent per annum. In the middle income category, however, between 1960 and 1974, there was a ten percent increase on share of oil in total energy balance, reaching 77 percent in 1974. In other words, this group depended totally on imported oil to meet its energy needs. Over the same period, the low income developing countries used oil as a "secondary" source of energy. The energy share as percentage of total consumption increased by 7 percent to 38 percent in 1974. Of this, domestic oil supplied 20 percent of the energy needs of these countries.[11]

In view of the current energy situation, the oil importing countries not only face the problem of meeting their oil requirements but are also confronted with an acute shortage of foreign exchange. In turn, this results largely from the high cost of imported food, raw materials and manufactured goods from the developed nations. The lingering recession of the last few years also compounds the ability of many developing countries to maintain a balanced structure of production and trade. Consequently, many poor countries continue to accumulate long- and short-term indebtedness to public and private lending institutions.

The unbalanced economies of many developing countries keep deteriorating, because various developmental sectors remain largely embryonic, and are thus too fragile to offset serious threats posed by shortages of a variety of raw materials, including energy. It is possible that many of the third world's energy deficient nations have not yet fully recognized the serious implications of the energy problem. For these nations, the necessities of daily existence, food, shelter, jobs, and possibly health care, take precedence over any systematic plans for the future. In recent years, however, the developing countries have had to bear the brunt of recession, inflation and the rising cost of world oil, in order to maintain their precarious position in the world community. From 1970 to 1974, the overall expenditures of the developing countries amounted to $14.9 billion, an $11.57 billion increase from their 1970 level. Projections of

[8]United Nations, *World Energy Supplies 1971-1975* (New York: Series J, No. 20, 1977).

[9]The projection of one percent increase in demand for oil is possible "if the price of oil remains constant in real terms, or by 2.7 percent p.a. should it decline to $7.00 (1974 = 100) by 1980." See Lambertini, *op. cit.*, p. 28.

[10]The use of inanimate energy or fossil fuel did not play an important role in the world pattern of energy consumption until the latter part of the nineteenth century. Coal, oil and natural gas gradually gained importance in world energy balance, replacing principally the animate and other sources of energy in Europe and the United States and later in other parts of the world. For an account of depleting reserves of fuelwood in some developing countries, see Erik P. Eckholm, "The Other Energy Crisis: Firewood," (Washington, D.C.: Worldwatch Institute, Worldwatch Paper no. 1) reprinted in Agency for International Development, U.S. Department of State, *Economic Digest*, vol. 14, no. 1 (Washington, D.C.: Government Printing Office, January, 1976), pp. 31-36.

[11]Lambertini, *op. cit.*, p. 28.

the demand for imported oil in these countries vary. However, it has recently been estimated that by 1980 the developing states will require about $44 billion to meet their petroleum demands and to maintain their already strained economic position.[12]

Other data indicate that between 1973 and 1974, the cost of oil imports of the developing countries increased by $9.4 billion to $13.1 billion in 1974. The increase in the price of oil during 1974-1975 is estimated to have added some $3 billion per annum to their expenditure on imported oil. In Africa, the share of net oil in total imports rose from 3.9 percent to 9.4 percent in 1974. In the Asian and Pacific Ocean countries, the share rose to 10.3 percent in 1974 alone, manifesting an increment of 5.8 percent from 1973. The Latin American nations experienced on average a 6.3 percent increase in 1974 over the net share of imports of 5.3 percent in 1973.[13]

Among the oil-deficient developing countries, some 29 states have generated the minimum rate of economic growth. Eighteen of these nations are situated in Africa; six in South Asia; two in the Arabian Peninsula; one in the Caribbean and the remainder in the Far East.

There are various ways of depicting their precarious balance. The chief indication, however, is their level of income. (See Table 2, inside back cover of this issue.)

A population totaling almost 250 million people comprises the world's poorest nations. Predominantly illiterate, rural in residence and occupation, their per capita income scarcely reaches $200 per annum. Between 1965 and 1975, the rate of growth for these states hardly exceeded 1.5 percent per annum. In many instances, declining growth trends hindered their ability to meet even the most rudimentary essentials of daily existence. Of the 29 states designated by the World Bank as "absolute poor," all but 14 are landlocked. Four are on the fringes of the Sahara Desert and have suffered almost a decade of drought and famine. Four more lie in the mountainous terrains of Hindu Kush and the Himalayas. To this day, most of these nations adhere to an ancient tradition. Absence of equality and, in most cases, rigid social stratification exacerbate the situation.

In 1973, the president of the World Bank observed that "among 40 developing countries for which data are available, the upper 20 percent of the population receives 55 percent of national income in the typical country, while the lowest 20 percent of the population receives 5 percent, a very severe degree of inequality."[14] In 1977, he stated that:

> The truth is that in every developing country the poor are trapped in a set of circumstances that make it virtually impossible for them either to contribute to the economic development of their nation or to share equitably in its benefits . . . . They are what I have termed the absolute poor: Those trapped in conditions so limited by illiteracy, malnutrition, disease, high infant mortality, and low life expectancy as to be denied the very potential of the genes which they were born with. Their basic human needs are simply not met.[15]

In view of the deepening poverty that faces the least developed countries and the rising costs of energy, especially oil, a substantial inflow of capital would be required to maintain their precariously low standard of living. Their inability to repay their outstanding debts, however, has greatly decreased the likelihood of loans from international or other sources. Since the "creditworthiness" of many developing countries has already been questioned by international lending institutions, it is not very likely that "they will be able to borrow significantly more in real terms, over the next five years, than they are doing now."[16]

Despite such strained economic conditions, in 1974, the net imports of raw petroleum of the 29 poorest countries amounted to $450 million, compared to $150 million in 1973. Thus, their net share of energy imports between 1973 and 1974 increased from 4.8 percent to 9.5 percent per annum.[17]

As a group, in 1974 these least developed states consumed about 11 million tons of coal equivalent in conventional sources of energy. On a per capita basis, their consumption of energy ranged from 140 kilograms to 14 kilograms of coal equivalent in the Sudan and Rwanda respectively. In 1974, similar differences in net imports of oil and related products ranged from $118 million in Tanzania to slightly over $2.5 million in Burundi.

In 1974, their share of oil in total net imports also showed significant variations, the highest being in Guinea and the lowest in Uganda, 29.6 and 0.5 percent, respectively.[18]

(*Continued on page 131*)

[12] E. N. Triatsoo, *op. cit.*, p. 372.

[13] Data for petroleum importing developing countries included: Ghana, Kenya, Sudan, Tanzania, and Zambia in Africa; Hong Kong, India, Philippines, Thailand and Turkey in Asia and the Pacific; Argentina, Brazil, Chile, Cuba, Jamaica and Mexico, as well as other states in these three regions. The figures concerning these countries have been drawn from different sources by the Centre for Natural Resources, Energy and Transport of the United Nations Secretariat, United Nations Economic and Social Council, Committee on Natural Resources, *Recent Energy Trends and Future Prospects* (New York: Publications Sales No. E/C.7/70, April 11, 1977), p. 31.

[14] Robert S. McNamara, *Address to the Board of Governors* (Nairobi, Kenya, September 24, 1973), p. 10.

[15] *Op. cit.* (Washington, D.C., September 26, 1977), p. 11.

[16] *Address to the Board of Governors*, 1975, *op. cit.*, p. 6.

[17] *Recent Energy Trends and Future Prospects*, p. 18.

[18] Derived from *ibid*, p. 32.

Feraidoon Shams B. is currently teaching at Howard University. Interested mainly in an interdisciplinary approach to the Social Sciences, for the past several years he has examined various sociopolitical problems in the developing nations.

"In the broadest sense of the word, conservation is the most rational utilization and maximization of a finite resource—petroleum."

Energy Options and Conservation

BY DOROTHEA H. EL MALLAKH

Associate Editor, Journal of Energy and Development

THE initial reaction of the industrialized world, especially the United States, to the oil embargo and the abrupt price increases in 1973 was to fashion responses to immediate energy needs—securing foreign oil and managing the financial burden of drastically higher import bills. In that autumn of 1973, United States President Richard Nixon again called for Project Independence, which envisaged United States self-sufficiency in energy by the 1980's.

The passage of time has brought expanding recognition of the full range of the global energy problem, looking ahead to the long term, when today's decisions may prove critical. The United States, the world's largest energy consumer and single largest importer (and, until recently, the largest producer), is very much a key element in the direction international energy policies will take.

Pricing, balances of payments and trade, and economic recovery, stability and development worldwide remain closely tied to the balancing of energy demand and supply through various policies aimed at reducing demand and increasing supply. Conservation is widely acknowledged as a direct means of dampening petroleum consumption. Yet implementation lags far behind pronouncements, particularly in the United States, whose government has yet to decide what targets should be set and what official policy should entail—how much "carrot" or incentives and what degree of "stick" or disincentives.

Moreover, projections of future energy (specifically petroleum) demand vary, based on differing assumptions of economic growth rates, development of alternate energy sources, and the impact of conservation (see Table 1). The high and low figures are premised on higher and lower economic growth rates of 4.5 percent and 3.5 percent, respectively;[1] the Central Intelligence Agency (CIA) estimates reflect adjustment for reduced growth and conservation.[2] Notably, within the total OECD (Organization for Economic Cooperation and Development) consumption pattern in 1974, oil and natural gas liquids (NGL) accounted for over 51 percent; for the United States in the same year, oil and NGL accounted for almost 45 percent of total energy consumption. The projections in Table 1 indicate little downward shift in oil's share.

Since a number of initial studies issued in 1975 by bodies like the OECD and branches of the United States government,[3] newer analyses have all been characterized by one dominant feature. Most significantly, the projections for contributions from sources other than oil have been revised consistently downward.[4] Indigenous oil supply estimates within the OECD have fallen from 1,312 Mtoe (million tons of oil equivalent) to 887 Mtoe; the more recent 1977 study similarly reduces natural gas output prospects for 1985 from 1,016 Mtoe to 773 Mtoe. Finally, nuclear power's expected contribution to 1985 OECD energy supply has been slashed from 748 Mtoe to only 464 Mtoe.[5]

The 1977 OECD findings carry a warning that the industrialized free world's net oil and gas imports for 1985 of 1,750 Mtoe could be even greater should the

[1]Organization for Economic Cooperation and Development (OECD), *World Energy Outlook* (Paris: OECD, 1977), p. 11. The members of the OECD include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Federal Republic of Germany, Greece, Iceland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

[2]Central Intelligence Agency, *The International Energy Situation: Outlook to 1985,* ER 77-10240 U (April, 1977), p. 7. The low case is based upon a continuation of the 1960-1973 trend, yielding a 1985 total OECD energy demand of 7,100 Mtoe, less 1,545 Mtoe adjustment for reduced growth, and less roughly 555 Mtoe for conservation.

[3]For example, Herman T. Franssen, *Toward Project Interdependence,* prepared for the United States Congress, Joint Committee on Atomic Energy (Washington, D.C.: Government Printing Office, 1975), and OECD, *Energy Prospects to 1985* (Paris: OECD, 1975).

[4]See OECD, *World Energy Outlook;* Library of Congress, Congressional Research Service, *Project Interdependence: U.S. and World Energy Outlook through 1990,* publication no. 95-31 (Washington, D.C.: Government Printing Office, June, 1977); Workshop on Alternative Energy Strategies, *Energy: Global Prospects 1985-2000* (New York: McGraw-Hill Book Co., 1977).

[5]OECD, *World Energy Outlook,* pp. 11-12.

TABLE 1: Energy Demand for the Industrialized Bloc, 1985
(in million tons of oil equivalent—Mtoe)

For	OECD Projections	CIA Projections	Other Projections
OECD total energy demand			
Low case	4,844.7	4,965.0- 5,105.0	———
High case	5,343.6	7,100.0	———
OECD demand for oil and natural gas liquids			
Low case	2,366.8	2,450.0	———
High case	2,689.5	2,805.0	———
United States total energy demand			
Low case	2,249.0	2,410.0- 2,520.0	2,173.8[a]
High case	2,475.7	3.095.0	2,069.1[b]
			2,245.2[c]
United States demand for oil and natural gas liquids			
Low case	959.4	1,110.0	950.0[a]
High case	1,130.4	1,280.0	907.2[b]
			1,083.3[c]

[a] Federal Energy Administration projections in CIA study cited.
[b] Department of Commerce projections in CIA study cited.
[c] Exxon Corporation projections in CIA study cited.

Sources: Organization for Economic Cooperation and Development (OECD), *World Energy Outlook* (Paris: OECD, 1977), pp. 94-95; Central Intelligence Agency, *The International Energy Situation: Outlook to 1985*, ER 77-10240U (April, 1977), pp. 7, 15; United States Congress, Office of Technology Assessment, Analysis of the Proposed National Energy Plan (prepublication draft, June, 1977). p. A-6.

commitments to expanding domestic energy supplies and conservation go unimplemented. The 1985 level of oil imports could rise if an indigenous output of 750 Mtoe cannot be attained through the discovery of new reserves and development of those existing, a target which requires a doubling of the historical finding rates. The conclusion is drawn that:

> This reference scenario implies strenuous effort in the form of considerable capital mobilization and reduced energy consumption. The lesson of the past three years is that it is an achievement that cannot be taken for granted.[6]

For the United States, the 1977 Library of Congress study indicates a similar revision downward on 1985 domestic production of various energy sources: oil from 12 million to 11 million b/d (600 Mtoe to 550 Mtoe); natural gas revised from 19 TCF (trillion cubic feet) to 17 TCF; coal down from 900 million tons to 850 million tons; a 25 percent slash in estimates of nuclear energy's contribution; and reductions in the potential shares of geothermal, shale oil, and other synthetic fuels. Only solar power has been adjusted upward, expected in the 1977 analysis to meet perhaps as much as 1 percent of the total energy demand of 1985 (about 25 Mtoe). The shortage between domestic United States supply and demand will be filled by imports; hence, the newer studies foresee imports of oil and natural gas by 1985 on the order of 13 million b/d (650 Mtoe) and some 14 million b/d by 1990 (700 Mtoe) rather than the 1975 study projections of 10.4 million b/d (520 Mtoe) for 1985.[7]

All these statistics reinforce the growing realization that, for numerous economic, financial, technological, and physical reasons and bottlenecks, raising domestic energy supplies within the United States and other oil-importing nations to meet even moderate economic-growth-rate-induced energy demand probably will not occur. The alternatives are dual: (1) reducing demand through conservation in the consuming countries and (2) expanding imports of required petroleum (crude oil and natural gas).

By reducing demand through conservation, the world is buying time—time required to develop new and expand existing energy sources—in order to smooth the transition from a petroleum-dominated energy base as that fossil fuel is depleted. An evaluation of the potential of conservation and of the results to date points up a critical feature, that is, once the early and relatively simple steps are applied, additional conservation measures are costly and difficult to implement vis-à-vis long lead times, investment, labor productivity, and/or the individual's convenience or purchasing power.

The International Energy Agency (IEA) of the OECD has proposed a 20 percent reduction in demand

[6] *Ibid.*, p. 9.

[7] Library of Congress, Congressional Research Service, *Project Interdependence*, pp. 7-8. The Central Intelligence Agency report, *op. cit.*, p. 15, places United States imports by 1980 at 500 Mtoe and 600 to 750 Mtoe by 1985, or between 54 and 66 percent of total United States oil demand.

TABLE 2: Estimated Conservation Potential within OECD, 1973 Compared to 1985

Energy Sector	Conservation Potential as % Total Energy Input per Sector	As % of Total Final Consumption (TFC)	As % of Total Energy Requirements (TER)
Electricity	4	---	
Petroleum	8	---	1
Others	10	---	
Industry	15–20	6–8	4–6
Transportation	37	9	7
Residential/commercial	15–20	5–7	4–5
Total	---	20–24	16–19

Source: OECD, *World Energy Outlook*, p. 64.

TABLE 3: Transport Sector Conservation Potential for Selected Countries and OECD, 1985 (as % of energy consumption for transport sector in 1985)

	Canada	U.S.	Japan	EEC	OECD
Conservation achieved					
Higher fuel prices	2.5	2.5	5–10	5–10	5.5
Existing speed limits	2.0	2.5		1.5	2.0
Total	4.5	5.0	5–10	6.5–11.5	7.5
Expected conservation					
New car mandatory fuel economy	30.0	25.0	---	---	12.5
Remaining conservation potential[a]	7.5–12.5	18.1–23.1	18.5	16.2	17.0
Total for new conservation	37.5–42.5	43.1–48.1	18.5	16.2	30.0
Overall conservation	42.0–47.0	48.1–53.1	23.5–28.5	22.7–27.7	37.0

[a]Includes such measures as: higher fuel prices; speed limits; improved automobile efficiency; shifts to more efficient modes (public transit and freight transport by rail); increased vehicle efficiency and load factor for trucks; operational improvements and better load factor in air travel; car pools.

Source: OECD, *World Energy Outlook*, p. 69.

by 1985, along the lines offered in Tables 2 and 3.[8] These estimates are founded upon three factors: (a) that the consuming nations have the proved technology required and (b) the technology is commercially feasible compared to assumed oil prices and (c) that new programs will be enacted in addition to *full implementation* of existing measures. Given the range of potential savings through conservation and the underlying assumptions on which the projections are based, the degree of success will depend on the individual consumer's understanding of the issue and his willingness to act and on the willingness of consumer country governments to make hard decisions that may have broad domestic political and economic ramifications.

How have consumers in the United States responded to the so-called "energy crisis" and specifically to the issue of conservation? Public opinion polls compared with data on actual consumption yield rather frightening discrepancies between what is perceived and the results.

From 1974 to 1977, the polls indicate consistently that at least half the Americans responding believed the seriousness of the energy shortages was exaggerated, that the crisis was caused primarily by high energy prices and the power of the oil companies, and that the problem was largely "manufactured" by the oil industry and by the exporting countries and through the mismanagement of the United States government.[9] Still more staggering was the Gallup poll of June, 1977, which found that only slightly more than half the United States public knew that their country was required to import any oil in order to meet its energy demand; 33 percent of those polled believed that the

[8]The countries participating in the IEA (established in November, 1974) are: Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[9]Rene Zentner, "The Myth of Energy Conservation," in *Energy Options and Conservation,* proceedings of the Fourth International Conference, University of Colorado, October 17-19, 1977 (Boulder, Colorado: International Research Center for Energy and Economic Development, forthcoming 1978).

United States was already self-sufficient in petroleum.[10]

Although conservation is regarded as a postive step toward reducing demand and thus dependence on foreign oil, a major obstacle is the firmly held belief of the American public that reduced consumption of energy (specifically petroleum) is linked to a lower standard of living. Moreover, according to the consumption pattern in the United States, less than half the total energy used can be affected by an individual, so that his actions can have an effect. Thus, public attitudes toward personal energy use are important in the residential (household) and transportation sectors. In 1977, over half the Americans responding to polls indicated that they had reduced the temperature in their homes; one-fourth indicated that they had taken at least two steps to conserve energy, like using appliances less, using alternate fuels, and the like. Similarly, in the transportation sector, one-third cut back on a planned trip, close to 30 percent considered or purchased a smaller car; nearly one-fifth were using a car pool.[11]

In the light of these responses, particularly in the transportation sector, where Americans have a long-standing love affair with a personal car, one would expect some reflection in appropriate consumption statistics. Yet Federal Energy Administration figures indicate that since 1975 motor gasoline demand has exceeded the 1973 pre-embargo level.

President Jimmy Carter's energy plan made conservation its cornerstone, with a forecast of voluntary conservation of 1 million b/d to be derived from a number of measures including a standby gasoline tax; the reaffirmation of the fleet average fuel economy standard of 27.5 miles per gallon for 1985; oil and natural gas taxes to bring these fuels to the world market level; utility rate reform like peak-load pricing and phasing out promotional electricity and gas rates; a development program for cogeneration of electricity and process heat; mandatory efficiency standards for new buildings; a national residential energy conservation program for existing structures.

Yet possibly the most significant feature in reducing energy consumption in the United States is the need for a drive to divorce lower energy use from the onus of a lower standard of living. There may be some changes in life-style but that is a different and not necessarily negative occurrence. For example, Sweden has a high standard of living and a dispersed population, and does not enjoy a temperate, let alone tropical, climate. Still, her energy use per unit of gross domestic product (GDP) is one of the lowest in the IEA: a total primary energy demand (TPE) to GDP ratio of 1.34 in 1973, 1.33 in 1975, and 1.37 in 1976. Compare this with the TPE/GDP ratio for the United States in the same years of 1.54, 1.51, and 1.49, respectively. Moreover, in 1976, the United States, France, Germany, and Japan had the highest growth rates within the OECD grouping; all but the United States effected a greater than average reduction in their energy/GDP ratios. Many countries that have been most successful in stimulating economic recovery from the recession of this decade have also managed to cut energy demand.[12]

Most of this study has been concerned with conservation as it affects energy demand; there is another valid form of conservation from the producing countries' viewpoint. The oil-rich nations have a three-way dependence on petroleum: as a source of energy, as the major (sometimes only) source generating the capital funds required for their development, and as the basis of industrialization in fields like petrochemicals (other industrial possibilities being restricted by a lack of non-oil resources). Both Libya and Kuwait have had production ceilings in effect for some time, based upon conservation of their petroleum reserves; the United Arab Emirates has announced a cutback in its 1978 production by some 265,000 b/d in order to maximize the ultimate recovery of oil from the reservoirs. Several Arab producers, including Kuwait, Saudi Arabia, and the United Arab Emirates, are unable to absorb domestically the oil revenues accruing from present output levels; this stimulates conservation of production for economic and financial reasons.

Projections on energy demand and supply worldwide indicate shortfalls by the coming decade, especially in petroleum. Expanding indigenous supply in the importing countries and conservation in consumption are viable energy options. But they will not suffice alone; imports of petroleum will still be required. Thus, the issue of conservation in output may figure in decisions that could affect oil prices as well as availability.

In the broadest sense of the word, conservation is the most rational utilization and maximization of a finite resource—petroleum. Clearly, there are a host of pressures and problems in which producers and consumers of petroleum have a shared concern. With the flexibility of the "low capital absorbers" to reduce production without any concomitant reduction in domestic development activity and spending, the Organization of the Petroleum Exporting Countries (OPEC) believes there will be no drastic reduction in oil prices even should demand be dampened. Thus OPEC members support the conservation efforts in the consuming nations. In short, conservation is perhaps not an alternative but an imperative. ■

[10] *Ibid.* Actually, more than 40 percent of United States petroleum demand in 1976 was met by imports of crude and refined products.

[11] *Ibid.*

[12] Samuel A. Van Vactor, "Energy Conservation in the OECD: Progress and Results," paper delivered to the RFF-EPRI Workshop on International Energy Consumption Comparisons, Brookings Institution, September 15-16, 1977.

Dorothea H. El Mallakh is Associate Editor of the *Journal of Energy and Development.*

"In contrast to the erratic record of Western powers, Soviet planners win relatively high marks for the long-range, purposeful and usually sound development and management of their energy resources."

Soviet Energy Resources and Prospects

By Leslie Dienes

Associate Professor of Geography, University of Kansas

The Soviet Union consumes almost 60 percent as much energy as the United States and more than the nine member European Economic Community,[1] yet it is self-sufficient in all forms of energy and is a major exporter. However, despite justifiable confidence in their country's long-term energy prospects, Soviet leaders are not complacent about the coming decades. The tenth five year plan (1976-1980) reaffirms the priority of heavy, power-oriented industries as the core of Soviet economic strategy and brings into sharp focus the need to expand fuel-energy supplies. Closely linked with these priorities, and for other reasons as well, greater efforts to develop Siberia and adjoining areas of the Asiatic U.S.S.R. will be apparent in the future.

Today, the energy mix of the Soviet Union is dominated by fossil fuels, and the contribution of primary electricity (power not generated from conventional fossil sources) is and has always been minor. The share of hydraulic power is declining and will drop by the end of the century to less than one-tenth of all electricity, while the contribution of nuclear plants, still very small, will grow markedly, to perhaps between 40 and 50 percent of electric power output.[2] However, since only one-fourth of Soviet gross energy supply today is converted to electricity (a share unlikely to double before the 21st century), fossil fuels, responsible for 96 percent of all energy used by the Soviet economy at present, should furnish over three-fourths of the total supply even by the year 2000.

Most fuels are consumed by stationary users in the form of heat (either as the object of final demand or for process steam and electricity). Overwhelmingly, these comprise boiler and furnace uses, accounting for four-fifths of all fuel consumption in very nearly the same proportions. Demand for motor and fleet fuel reached only 15 percent of the Soviet total in 1970, while less than 5 percent was claimed as raw materials by the chemical industry.[3] These figures are consistent with the sectoral distribution of demand, particularly the low share of transportation which, despite the vast size of the country, in 1970 claimed only 12 percent of all energy[4] compared to more than one-quarter in the United States.[5] The motor and naval markets and the bulk of chemical synthesis are technologically tied to petroleum, but other uses are more or less open to all fuels; the economic advantages of quality fuels over inferior fuels are least apparent for boiler use. Soviet experts project a significant growth in the share of boiler use (for electricity, steam and hot water) from 37 percent today to 47 percent some 15 years hence.[6]

A key question of Soviet energy policy, therefore, is the choice of fuel for the rapidly expanding boiler market, particularly for power plants, which account for 75 percent of all boiler use. In the early 1970's, one-fourth of all petroleum products and over two-fifths of natural gas were burned for the generation of electricity, steam and hot water.[7] Reducing or at least stabilizing the demand for gas and, especially, oil has become urgent, although it will not be easy. The gradual electrification of hitherto neglected sectors will intensify the peaking problem in power generation, and solid

[1]United Nations, Department of Economic and Social Affairs, *World Energy Supplies, 1971-1975* (New York, 1976), pp. 18ff.

[2]*Teploenergetika,* no. 4, 1970, pp. 5, 7; A. Lalaiants, "Dva obshchestva . . . ," *Planovoe khoziaistvo,* no. 4, 1975, p. 26 and N. W. Mel'nikov, *Toplivnoenergetcheskie resursy SSSR* (Moscow), 1971, p. 7.

[3]Mel'nikov, *op. cit.,* p. 192.

[4]P. S. Neporozhny et al., "Fuel and Power Economy of the Soviet Union . . . ," *Ninth World Energy Conference,* Detroit, 1974. *Transactions,* vol. 2, p. 149.

[5]*Statistical Abstract of the United States, 1974* (Washington, D.C.: U.S. Government Printing Office, 1974), p. 515.

[6]Neporozhny et al., *op. cit.,* p. 156. If non-energy uses, losses and exports are excluded from the totals, the shares of boiler use become still larger. The reasons are found in the increasing importance of electricity and the intention to reduce the need for small heating units, such as furnaces for individual apartment buildings.

[7]In 1973, this amounted to over 80 million tons of petroleum products and some 100 billion cubic meters of natural gas. United States, Central Intelligence Agency, *Soviet Long-Range Energy Forecasts,* A(ER) 75-71, September, 1975, p. 19.

fuels are unsuitable to cover the peak load. The new emphasis on clean air will cause most TET's (thermal plants distributing steam, hot water and electricity to urban neighborhoods) to burn gas or fuel oil. Finally, the distance between markets and the major centers of incremental coal supply, coupled with the poor physical properties of most cheap coals, will seriously limit the geographic range and economic effect of coal substitution.

Four-fifths of all Soviet energy today is consumed in the European U.S.S.R. (including the Urals and the Caucasus), and some 55 percent is consumed west of the rivers Volga and Kama. Many decades of exploitation, coupled with worsening geological conditions, have sharply raised fuel costs in these regions. Exploitation has also led to a rapidly growing physical shortfall and a massive energy flow from the Asiatic U.S.S.R. to the European provinces and further west. With exports, this flow reached 361 million tons of standard fuel (henceforth SF),[8] of which 124 million tons were represented by natural gas, 162 million tons by oil and the rest by coal. By 1980, such movement of fuel from Soviet Asia is planned to exceed 700 million tons of SF,[9] since by that date the European U.S.S.R. and the Urals are expected to satisfy only 60 percent of their energy requirements from their own resources—a share which is to fall to some 40 percent at the end of the 1980's.[10]

[8]The conversion ratios used by the Soviet yearbook are: 1 ton of standard (or conventional) fuel = 7 million kilocalories. One ton of crude oil = 10 million kcal (1.43 tons of SF); 1000 cu. meters of natural gas = 8.4 million kcal (1.20 tons of SF). Soviet lignites per physical ton range from 2 million to 4 million kcal (0.29 - 0.57 tons of SF), hard coals from 4 million to about 6.5 million kcal (0.57 - 0.93 tons of SF).

[9]A. M. Nekrasov and M. G. Pervukhin, *Energetika SSSR v 1976 - 1980 godakh* (Moscow), 1977, p. 148.

[10]G.V. Ermakov et al., "Trends in the Development of the Nuclear Power Industry," *Ninth World Energy Conference,* vol. 5, p. 279.

[11]In both the Russian Republic and the Ukraine, the net reproduction rates have been below replacement level (i.e., less than one offspring per each person of reproductive age) for over a decade, while in Belorussia this level was reached in the early 1970's. B. S. Khorev, *Problemy gorodov* (Moscow), 1971, pp. 241-42; L. P. Shakhot'ko, *Rozhdaemost' v Belorussii* (Minsk), 1975, pp. 142-43 and B. S. Khorev and V. M. Moisenko, *Migratsionnaia podvizhnost' naseleniia v SSSR* (Moscow), 1974, pp. 80. Since the abolition of forced labor transfers, the migrants to the pioneer regions of Siberia have been almost exclusively Slavs and primarily Russians.

[12]For example, the Soviet oil industry directly consumes 14 percent of its output in refining and field operation and uses some 100 KWH of electricity per ton of oil produced. Large gas pipelines consume 6 to 7 percent of the gas transmitted per every 1000 km. Line losses and station use account for 15 percent of gross electricity consumption in the U.S.S.R. M. B. Ravich, *Toplivo i effektivnost' ego ispol'zovaniia* (Moscow), 1971, p. 203; *Neftianik,* no. 6, June, 1975, p. 7; *Energetika i transport,* no. 1, 1975, p. 122; L. Samsonov, *Rol' elektrifikatsii v povyshenii effektivnosti obschchestvennogo proizvodstva* (Moscow), 1974, p. 142 and *Elektricheskie stantii,* no. 1, 1971, p. 2.

The neighboring COMECON (Council of Mutual Economic Assistance) states of East Europe are also critically dependent on Soviet petroleum and increasingly dependent on Soviet gas and, to some extent, coking coal and electricity. Commitments to all COMECON states for the entire 1976-1980 period amount to 364 million tons of oil, about 90 billion cubic meters of natural gas and 67 billion KWH of electricity, all except some one-tenth of the oil (destined for Cuba) going to East Europe. And while petroleum deliveries to these states are unlikely to grow, annual exports of gas may easily double or even triple in the next decade.

Current planning policies impose severe restrictions on the further location of energy-intensive industries in the European provinces. Expansion of such industries is to take place mostly in south central Siberia and parts of Kazakhstan, where vast supplies of cheap but low quality coal and hydroelectricity can provide energy at uncommonly low cost. However, beyond a narrow range of industries, accelerated development in this area would involve a heavy commitment of manpower on a scale impossible to sustain, given the precipitous decline of East Slavic birthrates and the net outflow of people from Siberia since the late 1950's.[11] Consumption of fuel and of electricity between the Urals and Lake Baikal has been increasing. In that area, per capita fuel consumption today exceeds the Soviet average by almost one-half and is surpassed only in the Urals and the Eastern Ukraine, the two principal heavy industrial bastions of the country, while per capita electricity use is more then 70 percent above the Soviet mean.

Yet with the gradual dispersion of manufacturing and greater supplies of energy to low priority sectors, per capita consumption has also grown in the underdeveloped regions of the European U.S.S.R. The Urals and European provinces, therefore, should account for over 70 percent of all demand into the 1990's. The heart of Soviet energy policy will remain the problem of furnishing these regions with fossil fuels, whose incremental supplies must come almost entirely from Soviet Asia.

The difficult resource conditions and the rapidly growing transport burden place heavy demands for material and other input on the economy. The fuel-energy industries already consume almost two-thirds of all pipes, up to one-fifth of all other products of ferrous metallurgy, about 15 percent of all copper and aluminum and 15 percent of the gross output of all engineering. The energy industries also consume a large portion of their own output, reducing substantially the amount of net energy available.[12] The steadily worsening geological and geographical conditions of supply will increase these burdens.

On an even calorific basis, petroleum is the largest contributor to the Soviet energy balance, accounting for 43 percent of all production and 37 percent of all

consumption in 1975.[13] In 1974, the U.S.S.R. overtook the United States in output (becoming first in the world) and in 1976 it produced 520 million tons, including condensates. The revised official 1980 target is 640 million tons.[14] A few years ago a Soviet energy expert hazarded 800 million tons as a projection by the late 1980's (with 900 million tons as the optimistic upper range[15]), but today it is very much open to doubt whether such an expansion is possible. At any rate, the average annual growth rates of oil production have been steadily declining, from 10.4 percent in the first half of the 1960's to 6.8 percent in the first half of the 1970's, and the current five year plan targets only a 5.4 percent yearly growth.

The annual increment is planned to remain steady at around 30 million tons through the 1970's but will decrease significantly in the following decade even if the earlier long-range projections are realized. Some Western experts predict that Soviet petroleum output will peak before the mid-1980's and the United States Central Intelligence Agency (CIA) forecasts an absolute decline.[16] The relative contribution of petroleum to the energy mix has reached its zenith, and even optimistic Soviet plans anticipate a noticeable drop in the forthcoming years.

The problem of future oil supplies involves both the availability of reserves and geographic distribution. Figures on Soviet petroleum reserves are classified. However, fragmentary data indicate that the proved plus indicated reserves ($A+B+C_1$ categories) total perhaps 10 billion to 11 billion tons (73 billion to 80 billion barrels), that is, a less than 20-year supply at the current rate of production, even if one assumes that virtually all indicated reserves are recoverable. With a recovery rate of 50 percent, new reserves of some 30 billion tons would have to be explored and developed to cover projected needs through 1990 while maintaining a 20 to 1 reserve-production ratio.[17] Since the early or mid-1960's this ratio has been declining. To maximize current output, Soviet leaders overemphasized development at the expense of prospecting and exploratory work: development drilling increased almost fivefold since 1950, but exploratory drilling has been lower in recent years than in the mid-1960's.[18]

Serious also is the downturn in output in most mature fields, despite sharply rising investment to maintain production levels. The 1976-1980 plan must create 390 million tons of new capacity just to offset depletion during the five years (as against 258 million tons in the previous five year period and 110 million tons in the second half of the 1960's) plus over 140 million tons of new capacity to guarantee expansion. Far more will be needed beyond 1980 when many mature fields will run practically dry. Thermal methods of recovery, now used to produce a mere 0.3 percent of petroleum, also will have to increase, and even the mining of heavy oil is being considered for the future. Soviet leaders have been proud of their technique of early and intense application of water flooding, claiming higher recovery rates from reservoirs than their United States counterparts. However, while maximizing yields during the early life of fields, such methods create significant production problems later on, as rapidly growing volumes of water are lifted to recover the oil and the fields are re-drilled to replace flooded wells. In the Soviet case, these methods have also inflicted serious damage to certain oil fields that were brought into production relatively recently in extreme haste.[19]

No less serious are the geographic problems associated with the development of the oil industry. In the European U.S.S.R., most fields have reached the plateau phase or are in already declining stages of exploitation. During the 1965-1970 period, the European provinces still accounted for 57 percent (61 million tons) of all increment in petroleum production. Between 1970 and 1975, they contributed only 8 percent (11 to 12 million tons) to the increment, and their share in total output fell from 82 percent to 61 percent. Eighty-four percent of all increment in the first half of the 1970's was accounted for by the new petroleum provinces of West Siberia alone, which must contribute more than the net national increase for the rest of the decade to compensate for declining production elsewhere. In 1976, West Siberia produced 182 million tons, or 35 percent of all Soviet oil and is scheduled to yield 310 million tons in 1980, nearly half the Soviet total. While proving Soviet determination, this crash program resulted in much damage to field pressure and, by Soviet admission, a loss of oil ultimately recoverable.[20]

New discoveries in the well-prospected regions west of the Urals are increasingly scarce. In the late 1960's, exploratory drilling for hydrocarbons was already proceeding at a depth of 3,500-4,000 meters in the Ukraine

[13]Computed as production minus *net* export. *Narodnoe khoziaistvo SSSR v 1975 godu* (Moscow), 1975, p. 240 and *Vneshniaia torgovlia SSSR v 1975 godu* (Moscow), 1976, pp. 25 and 40.

[14]*Ekonomicheskaia gazeta,* no. 8, February, 1977, p. 2.

[15]L.A. Melent'ev and A.A. Makarov, "Osobennosti optimizatsii razvitiia. . .," *Energetika i transport,* no. 3, 1974, p. 16.

[16]Robert E. Ebel, "Soviet Oil Looks to the West," *Petroleum/2000, the Oil and Gas Journal Special Supplement,* August, 1977, pp. 503-508; U.S. CIA, *Prospects for Soviet Oil Production,* ER 77-10270, April, 1977, and ER 77-10425, July, 1977, and *A Discussion Paper on Soviet Petroleum Production, Advisory Committee on East-West Trade,* June, 1977.

[17]*World Oil,* August 15, 1976, p. 44; *The Christian Science Monitor,* February 25, 1975, p. 4; U.S. CIA, *Prospects for Soviet Oil Production,* ER 77-10425, July, 1977, pp. 30-33 and *Ekonomicheskaia gazeta,* no. 11, March, 1974, p. 7.

[18]*The Oil and Gas Journal,* October 10, 1977, p. 73.

[19]This applies particularly to the fields of West Siberia and Kazakhstan.

[20]Kuzovatkin, chief of the largest oil trust in West Siberia, openly declares his doubt about the attainability of the 1980 targets.

and Belorussia, and in the Lower Volga-North Caspian regions a few wells are now being drilled to below 5,000 meters.[21] Similarly, offshore exploration continues in the Caspian and has begun in the Azov, Black and Baltic Seas, as well as in the European Arctic. Still, for the foreseeable future the Soviet oil industry will be critically dependent on the harsh and remote Asiatic provinces not only to provide incremental supplies, but increasingly also to compensate for declining output elsewhere.

East of the Urals, in the primeval swamps of the Middle Ob' Basin, the cost of road construction exceeds 0.5 million rubles per kilometer, dozens of tractors disappear in the marsh each year, and drilling crews must work from man-made islands that take years to build. The northern half of West Siberia and nine-tenths of East Siberia and the Far East are underlain with almost continuous permafrost and experience annual average temperature variations of 70° to 100° F, thus requiring very expensive and highly specialized construction technology. Road construction costs are reported to reach 1.1-1.6 million rubles per kilometer. Conditions in the barren deserts east of the Caspian are little better, and the high viscosity of most of the crude presents great problems for production and delivery even through heated pipelines. The prolific Middle Ob' fields will be the mainstay of the oil industry's growth until the end of this decade, but they, too, will mostly peak by that time.[22]

Further production increases in West Siberia will require the discovery and development of large deposits in the northern half of the region under still more difficult conditions, including permafrost. If more distant production goals are to be reached, the 1980's must also see an intensified prospecting effort on the vast East Siberian Platform, with a very complex geology, the harshest climate in the U.S.S.R., 1,500-2,000 kilometers further east than the fields of the Middle Ob'.

[21] *The Oil and Gas Journal,* October 10, 1977, pp. 92-100, and V.N. Kal'chenko, *Gazova promislovist' i tekhnichnii progres* (Kiev), 1972, pp. 72-75.

[22] In West Siberia, the Russians staked the bulk of their effort on the giant Samotlor field, which today accounts for almost three-fifths of all West Siberian output and is probably producing more crude than any field in the world except for Saudi Arabia's Ghawar. The reservoir peak by 1978 and further increments will have to come from smaller, more scattered fields which, by Soviet admission, will also have to be put into production with very little study of the geological structure of the petroleum beds. V.P. Maksimov, *Exploitation of Petroleum Deposits in Complex Conditions* (Moscow), 1976, as translated by Joint Publication Research Service L/7372, September 15, 1977, pp. 27 and 5-34; *The Oil and Gas Journal,* April 12, 1976, pp. 27-29 and September 1, 1975, pp. 62-63.

[23] U.N., Economic Commission for Europe, *Annual Bulletin of General Energy Statistics for Europe, 1975* (New York, 1977), p. 114.

[24] *Ekonomicheskaia gazeta,* no. 6, February, 1977, p. 1 and Melent'ev and Makarov, *op. cit.,* p. 16.

Of all fuels, crude oil is the most transportable and the cheapest to move. A 1220 mm. (48 inch) crude pipeline can pump 80 million to 90 million tons per year, depending on the number of pumping stations, equal to the calories carried by 5 gas pipelines of similar diameter, or those carried by 120,000-140,000 railway wagons hauling hard coal. The Russian crude petroleum industry no longer has a pipeline bottleneck. At the end of 1975, almost 47,000 km. of pipelines transported nine-tenths of all crude output, and the big Siberian fields today are linked with 40-inch and 48-inch lines to major refinery and market centers and to ports on the Black and Baltic Seas. Nonetheless, further expansion of about 15,000 miles is planned by 1980 to tap new fields and to handle production increases.

Soviet refineries today handle 83 to 84 percent of all crude oil output (a reported 383 million tons in 1974)[23] and, with the planned increase in capacity, should refine 510 million to 530 million tons by 1980, leaving roughly 110 million tons of surplus crude. Soviet planners have refused to follow the European pattern of maximizing heavy distillates (mostly fuel oil) in their refinery mix. Large investments in cracking, reforming and other secondary capacities continue to increase the yield (and upgrade the quality) of light products, and less than two-fifths of all refinery runs now consist of straight distillation. Of all refining capacity, no more than 70 million tons of capacity today seems to be operating in the Asiatic U.S.S.R. Major expansions under way should raise this to some 90 million tons in the early 1980's, still no more than one-fifth of the Soviet total.

NATURAL GAS

Today, natural gas contributes one-fifth of all Soviet energy production and nearly 23 percent of all consumption, and these shares should continue to increase for at least 15 years. In 1976, the U.S.S.R. produced 321 billion cubic meters, three-fifths of the United States total. With 435 billion cubic meters in 1980, according to the revised five year plan target, and tentatively perhaps 900 billion cubic meters ten years later, Soviet gas output should surpass the declining American level at the beginning of the 1980's.[24] Explored reserves of gas by Soviet claims are by far the

(*Continued on page 131*)

Leslie Dienes' research interests focus on the U.S.S.R. and East Europe, particularly Hungary. He has contributed articles on industrial location problems, energy policy issues and regional development to geographical and interdisciplinary (Slavic and energy) journals in both the United States and abroad and is the author of *Locational Factors and Developments in the Soviet Chemical Industry* (Chicago: University of Chicago Press, 1969). He traveled in East Europe and the U.S.S.R. during 1970-1971 and 1974.

"As of December, 1977, the energy supply picture of the People's Republic of China . . . appears not so rosy as the projections made two years ago."

China's Energy Resources

BY CHU-YUAN CHENG
Professor of Economics, Ball State University

CHINA is one of the few major countries in the world to have weathered the recent world-wide energy crisis virtually unscathed. In large part, China's relative immunity to soaring energy prices can be attributed to the strenuous efforts of the People's Republic to achieve self-sufficiency in energy supplies since the 1949 revolution. By 1976, China ranked third in the world as a coal producer and tenth as an oil producer. As Peking has embarked on an ambitious program to become a major oil exporter, the People's Republic of China's relative importance in world energy markets will probably increase significantly in the 1980's.*

Despite substantial advances in energy production, however, China's teeming millions still rank among the lowest in the world in per capita energy consumption. Moreover, the rapid expansion and concomitant investment in the petroleum industry have been partially at the expense of the coal industry—the mainstay of China's energy supply. Indeed, the languishing coal industry is a strong factor in the decline of China's average annual growth rate in total energy supplies. The trends of the past few decades, however, suggest that oil will probably become China's major source of energy in the long run.

Prior to 1949, geologists regarded China as a country with vast coal reserves, but generally deficient in petroleum resources. *The General Statement on the Mining Industry,* issued by the Geological Survey of China in 1935, estimated China's total coal reserves in 1934 at 243,669 million metric tons. In 1947, the figure was officially revised upward to 444,067 million metric tons.[1] After the establishment of the new government in 1949, extensive geological surveys were conducted, resulting in continuous upward revision of coal reserve figures, from 1,500 billion metric tons in 1955 to 9,000 billion metric tons in the Great Leap year of 1958. However, there is little detailed evidence to support the rapid increase in coal reserves. All these figures apparently refer to possible reserves not proven and probable reserves. After the dust of the Great Leap settled, the State Statistical Bureau, in 1960, published its *Ten Great Years,* estimating the volume of proven coal reserves at the end of 1958 at only "over 80 billion tons."[2]

In contrast to the rich coal reserves, Western geologists long maintained that the type of rocks and their genetic age precluded the possibility of petroleum deposits worthy of exploitation throughout most of China.[3] In 1949, the probable oil reserves in China were officially estimated at only 200 million tons.[4] The Great Leap Forward Geological Prospecting and Exploration Program in 1958-1959 significantly enlarged the proven reserves. Total potential reserves in 1960 were officially estimated at 2.9 billion tons, in contrast to the 1.7 billion tons estimated for 1957.[5] According to A. A. Meyerhoff, at the beginning of 1969, China's proved-plus-probable-plus-potential reserves of natural crude oil totaled 2.68 billion metric tons. Of this total, 182 million tons were considered as proved reserves and 777 million tons were probable reserves, for a total of 959 million tons in proved and probable crude oil reserves.[6]

Official Chinese reports reveal that large-scale oil prospecting has been going on in many parts of China since 1966 and that many new oil and gas fields have

*Much of this article is reprinted from a previous article by Chu-yuan Cheng, "China's Energy Resources," *Current History,* vol. 71, no. 419 (September, 1976), pp. 73ff.

[1]Yuan-li Wu with H. C. Ling, *Economic Development and Use of Energy Resources in Communist China* (New York: Praeger, 1963), pp. 33-34.

[2]State Statistical Bureau, *Ten Great Years* (Peking: 1960), p. 14.

[3]Chu-yuan Cheng, *China's Petroleum Industry: Output Growth and Export Potential* (New York: Praeger, 1976), p. 3.

[4]*Shih-yu K'an-t'an* [Petroleum Exploration] (Peking), no. 3, 1960, p. 1.

[5]Cheng, *op. cit.*, p. 85.

[6]A. A. Meyerhoff, "Development in Mainland China, 1949-68," *The American Association of Petroleum Geologists Bulletin,* vol. 54, no. 8 (1970), pp. 1,567-80.

TABLE 1: Estimated Production of Coal, Crude Oil, Natural Gas, and Electric Power in China, 1949-1976

Year	Coal (in million metric tons)	Crude Oil (in million metric tons)	Natural Gas (in billion cubic meters)	Electric Power (in billion kilowatt hours)
1949	32.43	0.12	--	4.31
1950	42.92	0.20	--	4.55
1951	53.09	0.31	--	5.75
1952	66.49	0.44	--	7.26
1953	69.68	0.62	0.01	9.20
1954	83.66	0.79	0.01	11.00
1955	98.30	0.97	0.11	12.28
1956	110.36	1.16	0.23	16.59
1957	130.73	1.46	0.33	19.34
1958	230.00	2.26	0.94	28.00
1959	300.00	3.70	1.42	42.00
1960	280.00	5.20	1.98	47.00
1961	170.00	6.00	2.83	31.00
1962	180.00	6.70	3.27	30.00
1963	190.00	7.50	5.66	33.00
1964	204.00	8.50	10.90	36.00
1965	220.00	11.00	11.32	42.00
1966	248.00	14.00	11.01	50.00
1967	190.00	11.00	10.47	45.00
1968	205.00	15.40	11.32	50.00
1969	258.00	20.70	12.70	60.00
1970	310.00	29.10	16.00	72.00
1971	335.00	37.50	19.50	86.00
1972	356.00	45.00	24.50	93.00
1973	377.00	53.00	30.60	101.00
1974	389.00	63.00	35.00	108.00
1975	427.00	75.00	35.00	121.00
1976	448.00	85.00	38.50	127.00
1977	494.00	92.00	47.00	139.00

Sources: The figures for coal and electric power for 1949 to 1974 are from Robert M. Field, "Civilian Industrial Production in the People's Republic of China," in U.S. Congress, Joint Economic Committee, *China: A Reassessment of the Economy*, 1975, p. 166.

Coal for 1975-76 and electric power for 1975 are from Central Intelligence Agency, *China: Economic Indicators* (October, 1977), p. 20.

Electric power for 1976 is estimated by the author based on information in *Ching-chi Tao-pao*, July 28, 1976.

Crude oil figures for 1949-75 are from Chu-yuan Cheng, *China's Petroleum Industry, op. cit.*, pp. 20-26. The 1976 figure is calculated by the author based on a report from NCNA (January 5, 1977) that crude oil output in 1976 was up 13 percent over 1975.

Natural gas figures for 1949 to 1974 are from Vaclav Smil, "Energy in China: Achievements and Prospects," *The China Quarterly*, March, 1976, p. 62. The 1975 figure for natural gas is from *China: Economic Indicators, op. cit.*, while the 1976 figure is calculated by the author based on the information from NCNA, January 5, 1977, which indicated that natural gas output in 1976 increased 11 percent over 1975.

The 1977 figures of oil and natural gas are for the first 11 months. The figures were reported by the NCNA on December 23, 1977, which gave the growth rates as follows: coal, 10.2 percent; crude oil, 8 percent; natural gas, 22.3 percent; and electric power, 9.8 percent.

been discovered. The most promising discovery, which has drawn worldwide attention, is the proclaimed offshore reserves in the continental shelf stretching from the Yellow Sea between Korea and the Shantung Peninsula as far as Hsi-sha (Paracel) and Nan-sha (Spratley) islands in the South China Sea. If initial prospects are proved, offshore oil may represent a prodigious addition to the Chinese petroleum reserves.

Recent estimates of possible Chinese oil reserves have been revised substantially upward, generally ranging from 10 billion to 50 billion metric tons. This wide discrepancy can probably be attributed to different conceptual frames of reference. While the low figure may refer to "probable reserves," the high figure most likely denotes "possible reserves." More recently, Chinese official reports have claimed that "many high-yield wells were drilled in China during 1974. Oil-bearing structures in some areas were confirmed to be larger than heretofore known, and promising oil and gas reserves were found in other areas."[7] This state-

[7]New China News Agency (Peking) (NCNA), August 8, 1974.

TABLE 2: Structure of Primary Energy in China, 1952-1976

Year	Total	Coal	Oil	Natural Gas	Hydroelectricity
		Million Metric Tons of Coal Equivalent			
1952	50	48	2	Negl	Negl
1957	110	103	5	1	1
1965	198	168	17	12	1
1970	303	231	43	27	2
1974	421	287	93	38	3
1975	464	315	99	46	4
1976	497	330	113	50	4
		Percent			
1952	100	97	3	Negl	Negl
1957	100	94	4	1	1
1965	100	85	8	6	1
1970	100	76	14	9	1
1974	100	68	22	9	1
1975	100	68	21	10	1
1976	100	66	23	10	1

Note: Supply includes net imports.
The coal equivalent employed has a calorific value of 7,000 kilocalories per kilogram.
Source: Native Foreign Assessment Center, Central Intelligence Agency, *China: Economic Indicators,* October, 1977, p. 26.

ment tends to reinforce speculation that the People's Republic of China may have the third largest oil reserves in the world.[8]

The relative growth of liquid and gaseous fuels at the expense of solid fuels constituted the most striking change in China's energy sources between 1949 and 1975. Until 1957, the end of the first five year plan, 96 percent of China's primary energy was derived from coal. Oil and natural gas represented a minuscule 3 percent, with the remaining 1 percent coming from hydroelectric power. A dramatic change began in 1965, when the Taching oil field in Heilungkiang began to operate on a large-scale basis. Subsequently, the Shengli oil field in the Shantung Peninsula and the Takang oil field in the Tientsin-Peking area were opened. China's output of oil doubled between 1960 and 1965, doubled again by 1969, and by 1976 equaled 1.7 million barrels a day (85 million tons a year), which was 16 times China's 1960 output.[9] (See Table 1.)

The rapid growth of petroleum output significantly increased the proportion of oil and natural gas in total Chinese energy production. The combined share of liquid fuels and natural gas rose from 3 percent in 1957 to 14 percent in 1965, 23 percent in 1970 and 33 percent in 1976, with a concomitantly steady decline in the relative share of coal. (See Table 2.)

Equally significant changes occurred in the geographic distribution of energy supply. In the pre-1949 era, most of the proven and probable coal reserves in China were located in North and Northwest China. In 1947, 67.6 percent of the coal deposits were concentrated in North China and 23.8 percent were situated in the Northwest. Together, these two geographical-administrative regions accounted for 91 percent of the proven coal deposits in Mainland China.[10] They were followed by Manchuria (Northeast), Central South China, Southwest China, East China and Inner Mongolia. By 1957, the two areas of North and Northwest China still held a total of 80 percent of the nation's total coal deposits. Yet the regional distribution of production did not correspond to the distribution of deposits. By 1942, as a consequence of Japan's special interest in the economic development of Manchuria, coal production in Manchuria accounted for 37 percent of the Chinese national output.

Coal production in the 1930's and 1940's thus centered in Manchuria rather than dovetailing with the general distribution of coal deposits in China. Under the aegis of the Japanese, Manchuria became the most industrially developed area in China in terms of heavy industry and rail transportation. Indeed, Manchuria also exported large quantities of coal to Japan during this period. This initial lead in Manchuria's industrial development carried forward into the post-World War II years; thus, three Manchurian provinces (Liaoning, Kirin, and Heilungkiang) accounted for one-fifth of the 1954 national industrial output.[11] However, by the 1960's, the richer veins of Manchuria's coal mines had been depleted. Consequently, mining costs per ton of

[8]P. Strauss, "China's New Claim," *Far Eastern Economic Review* (Hong Kong), no. 19, May 14, 1973, p. 41.
[9]Chu-yuan Cheng, "China's Future as an Oil Exporter," *The New York Times,* April, 1976, Section F, p. 14.
[10]Yuan-li Wu and H. C. Ling, *op. cit.,* p. 37.
[11]Nai-ruenn Ch'en, *Chinese Economic Statistics, A Handbook for Mainland China* (Chicago: Aldine, 1967), pp. 214-215ff.

coal have risen. Increased mining costs paralleled by post-revolutionary emphasis on developing the interior provinces resulted in a change in the regional distribution of coal production. Thus, in 1959, according to a Soviet source, Manchuria accounted for over one-third, North China for about one-third, East China for 16.3 percent, Southwest China for under 10 percent, Northwest China for 3.3 percent and South China for only about 1 percent, with the remaining 2.7 percent ascribed to the rest of the country, primarily Central China.[12]

The emphasis on producing coal in the Northeast (Manchuria) while the major known deposits were located in the Northwest was not paralleled in the case of the petroleum industry. Both known deposits of petroleum and production were concentrated in the Northwest area during the 1940's and 1950's. Prior to the opening of the Taching oil field in Manchuria, more than 90 percent of China's natural oil resources were concentrated in three fields in the remote desert and mountain areas of the northwest — Yumen in Kansu Province, Karamai in the Sinkiang autonomous region and Tsaidam in Tsinghai Province. These fields are more than 1,500 miles from eastern industrial and population centers. Their exploration involved very heavy overhead costs, and shipping millions of tons of crude oil from these remote areas to east coast refineries heavily taxed the resources of the only railroad serving the two regions.

The opening of the Taching, Shengli and Takang oil fields during the past decade provided new stimulation for the Chinese petroleum industry. The development of new oil resources near the industrialized coastal areas constituted a seminal change in the geographic distribution of oil-producing facilities, resulting in sharply reduced costs of production and transportation. By 1974, crude oil turned out by Taching, Shengli and Takang accounted for more than two-thirds of the national output. This radically transformed China's oil distribution system and enabled China to become a net exporter of oil.

DEVELOPMENT IN ENERGY INDUSTRIES

Between 1952 and 1974, China's energy production grew at a 10.4 percent average annual rate, with coal and oil averaging 8.5 and 23.2 percent, respectively. Thus, the annual growth rate of energy production surpassed the 8.4 percent growth rate of industry in the same period. However, the rate of increase in energy production trended downward from 14.7 percent per annum in 1952-1957 to 9.4 percent per annum in 1957-1965, 9.2 percent per annum in 1965-1970 and 8.8 percent per annum in 1970-1974. The major cause of this descending rate of increase was apparently the diminishing productivity of the coal industry.

As shown in Table 2, as late as 1974 coal still constituted 68 percent of China's energy supply. However, during the last 26 years, coal production has experienced an erratic rate of growth, trending downward from 14 percent per year in 1952-1957, to 7.8 percent per year in 1957-1965, 6.6 percent per year in 1965-1970 and only 5.6 percent per year in 1970-1974.

The declining rate of increase in coal production can be accounted for primarily by two factors: the geographic disparity between the regional demand for coal and the actual location of the coal reserves, and the relatively small investment in the coal industry over the past two decades. As noted previously, Manchuria ranked highest in regional coal production, although she possessed small regional coal reserves. In 1970, Manchuria produced 30 percent of China's total coal, while she possessed but 2.7 percent of the estimated coal reserves.[13]

Since the rich coal mines near the major metallurgical centers in southern Liaoning Province such as Penshi and Fushun have been under large-scale mining for more than half a century, the most accessible and best situated coal veins have already been depleted. Increasing the acquisition of supplies of coal for this highly industralized region requires increasing recovery costs, making it difficult to sustain the former high rates of growth.

Inadequate investment in the construction of new coal mine centers also caused the decline in coal production. Since 1960, the development priority for energy industries apparently shifted from coal to oil. Between 1953 and 1974, an estimated total of 21 billion yuan, or approximately $9 billion, was invested in the petroleum industry.[14] As the lion's share of capital was allocated to the petroleum industry, funds available for the development of the coal industry were sharply curtailed.

Although current published data with respect to the shortage of investment in coal mines is not available, government statistics for 1955 indicated that fixed assets

(*Continued on page 136*)

[12]Ya. M. Berger, *Kitai economiko-geograficheskity* [China, An Economic Sketch] (Moscow), 1959, in JPRS translation no. 6394, pp. 32-35.

[13]U.S. Central Intelligence Agency, *People's Republic of China: Atlas* (Washington, D.C., 1971), p. 69.

[14]Chu-yuan Cheng, *op. cit.*, pp. 111-113.

Chu-yuan Cheng is the author of *China's Petroleum Industry: Output Growth and Export Potential* (New York: Praeger Publishers, Inc., 1976), *Economic Relations Between Peking and Moscow* (New York: Praeger Publishers, 1964), *Scientific and Engineering Manpower in Communist China* (Washington, D.C.: National Science Foundation, 1966) and *The Machine-Building Industry in Communist China* (Chicago: Aldine-Atherton, 1971). He is working on a new book, *China's Economic Development: Growth and Structural Change,* to be published by Westview Publishers.

"The comparatively low price of oil has actually dampened efforts toward conservation in consumption and toward the expansion of other energy supplies that are not yet competitive with petroleum. Given the influence of time and economics in the global energy perspective and given the wide geographical dispersion of resources, technology, and capital, international cooperation is the only rational approach."

OPEC: Issues of Supply and Demand

BY RAGAEI EL MALLAKH
Professor of Economics, University of Colorado

THE December, 1977, semiannual meeting of the Organization of the Petroleum Exporting Countries (OPEC) in Caracas, Venezuela, resulted in a price freeze; the price for the Arabian Light "marker" crude will remain at $12.70 per barrel. This stabilization in price brought a sigh of relief from consuming capitals. The significance of the Caracas decision derives from the fact that neither the ongoing global inflation nor the weakness of the dollar was reflected in an oil price increase. OPEC's freeze showed an understanding of the slow international economic recovery, particularly of the industrialized Western bloc. And unlike the Doha (Qatar) meeting a year earlier, the disagreement among various OPEC members on pricing was not manifested in a dual-tier system. At that conference, the members, except for Saudi Arabia and the United Arab Emirates, supported a 10 percent hike; the two dissenters favored a 5 percent increase.[1]

Because the two "heavyweights" in the international oil trade—Saudi Arabia and Iran—with the support of the United Arab Emirates, Kuwait, and Qatar (i.e., the Arabian/Persian Gulf members who account for two-thirds of OPEC output) had concurred in holding the price at the prevailing level, the outcome of the Caracas session was never in question. Those countries that favored an increase, Venezuela, Iraq, Libya, Algeria, and Nigeria, could register their disagreement only verbally, not financially.

A number of OPEC critics have viewed the differences in pricing positions among the members as evidence of the organization's impending collapse. In fact, OPEC's loose-knit structure and the strict limitations placed on its power vis-à-vis its membership have made it more of a debating forum and repository for very broad and general concepts, with a high degree of resiliency and flexibility.[2]

OPEC's ability to play a major role in the international petroleum trade and, more recently, in world finance is enhanced by a medium- and long-term "seller's" market through the 1980's, and a recognition by the members of the benefits that have accrued to them through solidarity as a producer bloc. Pricing differences among members have focused on the amount of a price increase, not on a price cut.

In early 1978, there was a glut in oil. But lest consumers begin to look for falling energy prices, it should be made clear that the surplus is only temporary. The arrival of Alaskan and North Sea oil has dampened demand in some importing markets for perhaps a year or two. Some sources place OPEC surplus availability at between 1.5 and 2 million barrels a day (b/d) in 1978; thus a return to a strong seller's market could materialize by 1980.[3] To bridge the anticipated "soft" market period, some of the larger-scale OPEC producers who enjoy substantial capital surplus standing can and probably will cut back their output. Saudi Arabia has announced a reimposition of her 8.5 million b/d production ceiling, and the United Arab Emirates has reduced its 1978 allowable output by 265,000 b/d; Kuwait and Libya have relatively long-standing conservation policies, with production ceilings remaining in place.[4]

Such unilateral production cutbacks reflect both the slack in the world oil market and other economic factors, including the maximization of recovery and loss of purchasing power through the decline in the value of their capital reserves caused by the weakening of the dollar. In short, when Saudi Arabia, the United Arab Emirates, and Kuwait cut back on output, no reduction

[1]The two-tier pricing system existed for about six months and was unified at the 1977 mid-year Stockholm OPEC conference when Saudi Arabia and the United Arab Emirates raised their price about 5 percent to bring about a single price level. The two-tier system, its causes and implications, have been outlined briefly in testimony by Ragaei El Mallakh to the Joint Economic Committee of Congress, Energy Subcommittee, *Congressional Record,* March 2, 1977, pp. S3335-S3337.

[2]OPEC's positions and decisions have never been binding on its members' governments; thus the organization only can and does move on matters of strong mutual interest.

[3]*Middle East Economic Survey,* December 26, 1977, p. 2.

[4]*Ibid.,* December 19, 1977, pp. 1, 3.

TABLE 1: Non-Communist Crude Oil Reserves as of January 1, 1977 (in billions of barrels)

United States	30.9
Canada[a]	7.4
United Kingdom	16.8
Norway	5.7
Other Western Europe	1.8
Australia/New Zealand	1.6
Non-OPEC developing countries	
Mexico	11.0
Other Latin America	5.6
Africa	6.6
Middle East	8.7
Asia	7.3
Total of non-OPEC developing countries:	39.2
OPEC	
Algeria	6.8
Ecuador	1.7
Gabon	2.1
Indonesia	10.5
Iran	63.0
Iraq	34.0
Kuwait	70.7
Libya	25.5
Nigeria	19.5
Qatar	5.7
Saudi Arabia[a]	177.5
United Arab Emirates	31.2
Venezuela	15.3
Total of OPEC:	463.5
Total	566.9

[a]Proved and probable reserves.

Source: Library of Congress, Congressional Research Service, *Project Interdependence: U.S. and World Energy Outlook through 1990,* publication no. 95-31 (Washington, D.C.: Government Printing Office, June, 1977), p. 59.

by these nations in their development spending is required and the production cut keeps the oil underground until a return to conditions of greater scarcity.

The underlying and undeniable strength OPEC emanates is the enormous crude oil reserve of its members. OPEC accounts for 82 percent of the free world's reserves; the industrialized bloc holds some 11 percent; and the non-OPEC developing nations' share is only 7 percent (see Table 1). Furthermore, some of the newer non-OPEC reserves are difficult to utilize.

For example, well over one-fourth of United States measured oil reserves are located in Alaska. Yet exploitation has proven costly in this frontier region, including the costs of constructing the lengthy pipeline across that state. Now an additional transport problem has arisen—moving tanker-delivered Alaskan oil from the West Coast to consumption centers east of the Rocky Mountains. Even if pipeline construction begins at once, the time lag may be so great that Alaskan oil will be unable to fulfill its potential in meeting United States demand.[5]

Another source of petroleum in the industrialized West only now coming on stream is the North Sea. Development drilling in that region has been forecast to peak between 1978 and 1980; production from the United Kingdom sector of the North Sea is expected to increase until 1985, then decline abruptly.[6] As for the other major North Sea producer, Norway, her production will be geared to meet her domestic demand, but government policy will not allow output to become heavily export oriented. For social and economic reasons, including the fear of overheating the economy and of environmental impacts, Norway has made a deliberate commitment toward prolonging the life span of her reserves through strictly regulated output.

A third major non-OPEC oil resource receiving recent attention is Mexican oil. The extent of Mexico's reserves is still questionable and offshore extraction costs will be high. As a developing country in need of capital funds, Mexico, unlike Norway, will actively seek export markets for much of her production. But while Mexican policy will result in some rise in the non-OPEC supply, the price per barrel will keep pace with the level established by OPEC. It is unlikely there will be bargain-priced oil from Mexico.

OIL TOMORROW

Given OPEC's control of non-Communist petroleum reserves, two questions can be posed: What level of production will be sought from OPEC to meet world demand? And to what extent can and will OPEC members meet global oil requirements?

Forecasts of future oil demand in the industrialized countries made two or three years ago have undergone sharp adjustments upward. In part, there was a misreading of the cause of the slump in petroleum consumption in 1974 and 1975; too much credit was given to the dampening of demand because of OPEC price hikes and not enough weight was given to the impact of the global recession and inflation that peaked almost coincidentally with the drop in oil demand. What was regarded as price-induced conservation in consumption was for the most part a recession-induced cutback in consumer spending.

On the demand side, the October, 1977, meeting of IEA (International Energy Agency) energy ministers was told that without strong action on the part of their membership, the IEA members' oil imports could reach 32 million b/d (about 1,600 million tons of oil equivalent per year) by 1985 unless the United States meets

[5]A discussion of the pipeline options relating to Alaskan oil is given in E. J. Cahill and D. E. Bayse, "North Slope Oil and United States Energy Supply," *Journal of Energy and Development* (spring, 1977), pp. 257-66.

[6]*Petroleum Economist,* November, 1977, pp. 423, 446. By 1979, the United Kingdom's North Sea output may be sufficient to meet all that country's liquid fuel requirements.

its import target of 6 million b/d for that year. The ministers learned that serious energy imbalances could occur by the early part of the next decade unless vigorous conservation measures are implemented and alternative energy sources are developed and/or expanded, specifically, increased coal usage and nuclear power production. The IEA reference projections are for ongoing rises in oil demand from both the industrialized and the developing importing nations to the year 2000.[7] A middle-of-the-road supply and demand alternative, that is, neither the most optimistic nor the most pessimistic, is offered in Table 2.

This table illustrates the speed with which petroleum demand will grow throughout most of this century; it also indicates that the major demands will have to be met from OPEC sources. The table projects OPEC supplying 61 percent, 62 percent, and 64 percent of the non-Communist oil demand in 1980, 1985, and 1990, respectively. If OPEC can and will produce enough oil to fill demand requirements, what will the price be?

Whether the oil-producing states will be able to meet demand depends on their actual physical productive capacity. There is no general agreement on exact figures for free world productive capacity to 1990. The upper and lower estimates are such that in each case (1980, 1985, and 1990) there could be a shortage or an excess in capacity. For example, the low and high forecasts on capacity by 1985 range from 64 million to 84.5 million b/d; projected non-Communist demand in that year (Table 2) is 68.8 million b/d.[8] In short, productive capacity is likely not to be a primary constraint in balancing supply and demand.

Whether the oil-producing nations are willing to lift the required amount of oil in that period of time depends on a number of factors. This willingness most probably will be the critical element in determining whether shortfalls occur. A growing sentiment within OPEC was recently voiced by an Algerian spokesman.

> One must, however, remain skeptical that either conservation or the development of new supply sources will ever do more than delay the day of reckoning. Even if our *best* hopes are achieved, OPEC will be called upon to produce 40% more oil in 1990 than it does today. While the OPEC countries will continue to recognize their responsibilities to the industrialized world, you should not assume that they can allow themselves to deplete their major—and often only—national resource in the lifetime of a single generation.[9]

TABLE 2: Non-Communist Supply and Demand Balance of Oil and Natural Gas Liquids (in millions of barrels per day—b/d)

	1980	1985	1990
Demand			
Consumption	54.8	66.9	76.3
Oil storage	1.9	1.9	—
Total demand	56.7	68.8	76.3
Supply			
Total OECD, other developed countries	15.6	17.3	19.1
Total non-OPEC developing countries	5.4	7.7	8.3
Total OPEC	34.6	42.8	48.9
Net exports of Soviet bloc	.6	0	0
Net exports of Peoples' Republic of China	.5	1.0	0
Net exports of Communist bloc	1.1	1.0	0
Total supply	56.7	68.8	76.3

Source: Library of Congress, Congressional Research Service, *U.S. Energy Demand and Supply, 1976-85; Limited Options, Unlimited Constraints,* prepared for the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, House of Representatives (Washington, D.C.: Government Printing Office, November 1977), p. 10.

The prevailing attitude toward pricing within OPEC is that the upper limit is dictated by the price of substitutes. For example, the price per barrel of oil derived from shale ($24) and tar sands ($27) is almost double that of OPEC crude in 1977. Moreover, substitution for oil can be made more easily in some uses than in others, e.g., in home heating and electric power generation through reversion to coal and, in the former case, utilization of some solar energy with the present level of technology. But for the so-called "noble" part of a barrel of crude oil, substitutes are not yet readily available and may never be for very specific uses. Consider the present role of motor gasoline in the transportation sector and the basic feedstock requirements of the vast petrochemicals industry.

Within OPEC, the swing nation for meeting demand is Saudi Arabia, because of her unmatched crude reserves (proved and probable), over five times the

(*Continued on page 138*)

[7]United States oil imports (crude and product) in 1977 have been running in the neighborhood of 8.5 to 9 million b/d. One knowledgeable but skeptical commentator has said: "Yet *no* competent review publicly available—save the forecast of the administration itself—believes the present program will . . . [bring] the volume to 6 million barrels a day or less." Melvin A. Conant in *Petroleum Economist,* November, 1977, p. 425. The IEA projections are given in *ibid.*, pp. 429-30.

[8]Library of Congress, Congressional Research Service, *Project Interdependence: U.S. and World Energy Outlook through 1990,* publication no. 95-31 (Washington, D.C.: Government Printing Office, June, 1977), pp. 59-61.

[9]N. Ait Laoussine, "Marketing of Oil and Gas: Sonatrach Case," paper delivered to the OPEC Seminar on the Present and Future Role of the National Oil Companies, Vienna, October 10-12, 1977, p. 5 (mimeographed).

Ragaei El Mallakh, director of the International Research Center for Energy and Economic Development at the University of Colorado, is also editor of the *Journal of Energy and Development.*

BOOK REVIEWS

ON ENERGY

VITAL RESOURCES. *By the Commission on Critical Choices for Americans.* (Lexington, Mass.: D.C. Heath and Company, 1977. 187 pages and index, $20.95.)

This is the first volume in a series of 14 to be published for the Commission on Critical Choices for Americans; the "commission is a group of 42 Americans headed by [former Vice President] Nelson A. Rockefeller to develop information and insights which would bring about greater understanding of the problems confronting America." This report on vital resources represents the work of 3 panels of that committee. Nelson Rockefeller was chairman of the commission until early 1975 and William Ronan is the current chairman. The panel members represent the world of politics, business and academia.

During the period since the commission was first formed, the Arab boycott was declared, OPEC was formed and the "world faced new economic challenges and strategic considerations. The era of cheap energy was ended. . . ." According to Rockefeller, "the three decades from the end of World War II saw America through three periods: the first, one of unbounded optimism; the second, one of critical cynicism and nascent conflict; and the third, the dawning of an era of sobering realism." The assumptions of the superabundance of the 1950's have contributed to the overcommitment of government to programs and prospects impossible to fulfill. They also contributed to delay and disagreement over those programs necessary to our survival like a practical energy program, which is still stalled in Congress. Rockefeller says that "energy conservation remains more a verbal policy than a practical reality, despite all the public attention devoted to it."

The report of the first panel deals with energy and its relationship to ecology, economics and world stability. United States dependence on "foreign oil production continues to grow. At the same time imports of all forms of energy have risen sharply, adding to consumer costs, reducing real income, and thus exerting a deflationary influence on the domestic economy. The high volume of imports exposes the United States to national defense and national security risks." Energy conservation is of vital importance and the development of alternate sources will require lead time and substantial amounts of capital; energy conservation measures and the increasing use of alternative sources will have an impact on the environment.

The panel outlines the choices open to Americans and gives the arguments pro and con for each of the choices. There are logical reasons for each choice but the panel agrees on a single imperative, that is, "the need to choose now what kind of an energy program we want."

The second panel performs a similar task with its report on food, health, world population and the quality of life. The third panel reports on raw materials, industrial development, capital formation, employment and world trade.

The tables in the text do much to enhance the reports; the presentation of choices leaves it up to the reader to make his own decisions but gives him a wealth of material to help him decide which path to take. O.E.S.

OIL, DIVESTITURE AND NATIONAL SECURITY. *Edited by Frank N. Trager.* (New York: Crane, Russak & Company, Inc., 1977. 135 pages, $4.95, paper.)

Frank Trager has selected a group of articles to show that the divestiture of the multinational oil companies would not help us to obtain normal supplies of foreign oil. If the large corporations are unable to combat OPEC prices and policies successfully, smaller companies would be even more helpless. "The energy shortage is real. It is persistent. We will never get back to 'normalcy' as we defined that term in the summer of 1973." The cheap oil era is gone forever "but not because oil companies are conspiring against the consumer." The problem is that the use of oil is increasing throughout the world.

THE ENERGY CRISIS: WORLD STRUGGLE FOR POWER AND WEALTH. *By Michael Tanzer.* (New York: Monthly Review Press, 1975. 171 pages, notes and index, $8.95.)

Michael Tanzer believes that there is "no real energy crisis, in the sense of a physical shortage of energy resources; rather, there is an artificially contrived scarcity generated by various forces operating within the overall framework of the international capitalist economy." Tanzer gives a short history of the oil industry and its relationship with "home governments" and the governments of the oil producing countries. He describes the impact of the oil price rise on third world countries. The final chapter offers proposals on "how the international energy crisis in theory could be overcome, and, more generally, how energy resources could be used ideally in a rational world." □

EUROPEAN AND JAPANESE ENERGY POLICIES

(*Continued from page 108*)

negotiating offshore oil leases and the Alaskan pipeline, one is impressed by the few administrative delays in Europe. This probably reflects the more centralized government systems of most European governments.

Apart from North Sea oil and gas, there is no non-nuclear fuel whose production can be significantly expanded before the 1990's. New coal reserves are being found in Britain, but both Germany and the United Kingdom will be concentrating on maintaining current levels of coal production rather than on expanding their share of the market (which will be around 12 percent-13 percent in 1985). So, in the absence of any other speedy solutions, many European countries turned their eyes to the nuclear option, with much the same results as found in Japan—vastly overambitious plans have continuously been scaled back until they are now perhaps approaching plans that are actually realistic. A classic example of the withering of the nuclear dream is the succession of estimates stemming from the EC commission of the amount of nuclear capacity there should be in 1985: in June, 1974, they talked of 200 GW; in December, 1974, 160 GW; by the end of 1975, 150-160 GW; in mid-1976, 125 GW; in July, 1977, 105 GW; and pessimistic guesses can put it as low as 85-90 GW.[22] On the most charitable assumptions, nuclear power might account for around 12 percent of OECD Europe's energy needs in 1985, but the odds are that the figure will be lower.

As is true of Japan, the difference between nuclear hopes and reality is related to slower economic growth and to some anti-nuclear protests. By mid-1977, for instance, there were 8 nuclear plants in the key German market whose construction was being blocked by legal protests,[23] and in November, 1977, the ruling Social Democrat party bowed to anti-nuclear forces and decided not to build more nuclear stations until coal-fired stations fueled by indigenous coal supplies could no longer be maintained. There were also strong anti-nuclear lobbies in Scandinavia. Even France—probably the European country least sensitive to grass-roots, environmentalist movements—was faced with violent demonstrations aimed at her latest model of fast breeder reactors.

Although there is tidal power potential off France, wave power potential off the United Kingdom and solar potential in southern European countries like France and Italy, it is clear that European governments will still probably put most of their immediate hopes on the nuclear option. They know that the continent has a technological lead in fast-breeder technology that should reduce their dependence on imported uranium—a consideration that was emphasized by 1977's United States-Canadian ban on enriched uranium exports to Euratom members,[24] which aimed to force the latter to tighten their nuclear safeguards. It is the fact that the EC has only 3.5 percent of the OECD world's uranium reserves that makes it so skeptical of United States arguments that we should re-think our approach to the plutonium-based fuel cycle. The United States has the uranium reserves to support a continued dependence on the current generation of nuclear reactors. The Europeans do not. And probably the majority of decision-makers in Brussels and the national centers believe that Europe cannot afford to hold back research in any technology that will reduce future European dependence on imported uranium. Whether they are right or not is another matter.[25]

THE WIDER IMPLICATIONS

We are now entering an era in which it becomes unproductive to analyze too narrowly the energy dilemmas facing any single country or region. Once governments have installed obvious defensive measures like oil stockpiles and have taken advantage of existing technologies to conserve energy and speed up the production of any rapidly available energy sources, then they are all in the same boat, casting round for whatever technological breakthroughs (in whatever energy field) are most suited to their own needs.

It is extremely unlikely that any one country will solve its energy problems by its indigenous research efforts alone. Rather, all breakthroughs will come from steadily sifting through research in all parts of the world. Attempts to find a purely British, Japanese, or even European solution to specific energy problems are likely to prove a waste of resources. Technology does not respect national boundaries.

Thus in the OECD world there are more and more examples of international cooperation in energy research on an a la carte basis in which governments support research projects that interest them, increasingly regardless of continents or political groupings. Old-style nationalist nuclear research programs are being internationalized, as when the French and Germans recently joined forces to produce a breeder technology that they could both export. One or two projects are being tackled on a purely EC basis, like the Joint European Tours, a research program aimed at tackling the nuclear fusion process. Increasingly, there are genuinely multinational projects, like the competing European uranium enrichment projects: Eurodif, which

(*Continued on page 136*)

[22] *Petroleum Economist,* April, 1977, p. 135; *Petroleum Intelligence Weekly,* September 5, 1977, p. 4; *World Energy Outlook* (Paris: OECD, 1977), p. 51.

[23] *Financial Times* (London), August 3, 1977.

[24] Euratom is the EC's nuclear energy arm.

[25] See the forthcoming Louis Turner and Audrey Parry, "The Next Steps in International Energy Co-operation," *World Today,* February, 1978, for further reading on the nuclear debate.

THE NATURE OF THE ENERGY CRISIS

(*Continued from page 99*)

difficult for the developing nations to catch up to the rich nations.

Second, we must moderate the growing demand for energy. One way of doing so is to slow and stop the population growth. Another possible way is to stop economic growth, although the loss of welfare in doing so is very high. A final possibility for moderating the increase in demand for energy is to improve the efficiency with which this energy is used. There is a great deal of evidence that energy is being used inefficiently in the United States.[14] Were we to desire to do so and were we to have time, we could produce the same amount of goods and services as we currently produce using about 40 percent less energy than we currently use.

Third, we must increase the supply of unconventional energy resources. There are abundant energy resources in the form of coal, oil shale, and heavy oil, which are unattractive compared with cheap petroleum and natural gas. However, we will have to expand our use of these fuels in the future. These resources have particularly severe environmental problems; much work must be done to make their use acceptable in terms of damage to the ecology in general and to human beings in particular.

At the same time, we must continue research and development to explore new technologies. There are four long-term energy sources for the world. If R&D is successful, any of these four resources promises an amount of energy sufficient to last indefinitely or at least for centuries. These four include the breeder reactor, fusion, the various solar resources, and geothermal resources.[15] To make any of these resources commercially available will require an immense amount of research and development; all four appear to be more expensive than current technologies and resources.

A fourth facet of the solution is to give increasing attention to environmental problems associated with energy. Every energy resource and every technology include risks to the environment and to health. From radionuclides to air pollution, acid rain, and climate change, the adverse consequences of each technology can be mitigated but not entirely prevented. Having begun to recognize these consequences, we must learn more about how to mitigate them. A particularly crucial short-term problem concerns coal, since coal use in the United States is projected to triple or quadruple by the end of the century. Unless ways are found to mine, transport, and burn coal better, the environmental and health consequences of quadrupling the use of coal are probably unacceptable.

A final facet of the solution is to inform the public, both in the United States and around the world, of the nature of these problems. People must understand the consequences of various alternatives and become more involved in deciding which solutions to pursue. Within the United States, citizen protests have stopped, or at least slowed, construction of large coal or nuclear electricity generation plants. With no way to balance the risks of one technology against another, people have reacted against one without thought of the implications for either the risk of insufficient energy or the risks of substitute technologies.

The energy problem is neither the greatest problem of our times nor the moral equivalent of war. Nonetheless, it is a problem that will cost us a great deal if we refuse to confront it or if we make hasty, uninformed decisions. By increasing our reliance on petroleum and natural gas, as we have been doing since the Arab oil embargo, we are laying the foundation for a disaster. Only public discussion and resolution of the problems of how much energy we desire and what technologies and resources we want to use will avoid this crisis. ■

[14]Darmstadter, *op. cit.*, Schipper, *op. cit.*

[15]See footnote 13.

U.S. ENERGY DEMAND AND SUPPLY

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arrives. But there is widespread disagreement over which coal and nuclear energy options should be pursued. Mid-term supply-demand balances will be significantly influenced by the outcome of two decisions: the choice among various coal gasification and liquefaction processes as substitute fuels for petroleum in the industrial and transportation sectors; and the resolution of the nuclear light water reactor-breeder reactor controversy in the search for electric power generation in the residential/commercial sector.

By the end of the mid-term, nonconventional sources will probably begin to make a substantial contribution to energy supply. Solar space heating and cooling technologies alone could produce perhaps as much energy by the year 2000 as is now being supplied by nuclear power. And geothermal energy, oil shale and biomass might produce even more output.

IN THE LONG-TERM

Long-term characterizations are by definition highly speculative, but four sources of renewable energy offer the promise of significant post-2000 supply contributions: the oceans, the internal heat of the earth, the sun, and atomic power.[11] Of the options for harnessing energy from the oceans, tidal power is a proved technology which suffers from a lack of feasible locations in the United States. On the other hand, ocean thermal gradient technology, which taps the energy in the difference in temperature of the ocean water at various

[11]See Carroll Quigley, "America's Future in Energy," *Current History*, vol. 69 (July/August, 1975), pp. 1-5.

depths, has unlimited production capability but is still at an early stage of development.

The heat of the earth, in the form of geothermal energy, can be utilized in four forms: vapor, liquid, geopressure, and hot-dry-rock. Only vapor systems are currently in operation in the United States—production technologies are unproved for all other geothermal resource types.

Energy from the sun may be captured either through windpower or direct radiation. Wind energy is technologically feasible, but it is limited by high costs and low efficiency levels. Solar thermal power and photovoltaic cells are even more constrained by economic barriers and problems of interfacing electric output with electricity demand (because of the intermittent nature of solar radiation). Finally, atomic energy from nuclear fusion offers an abundance of cheap fuel and lower levels of radioactive waste products than the mid-term nuclear fission alternatives. But fusion technology is at an early stage of research, since the controlled fusion reaction has yet to be achieved.

This discussion has emphasized the need to consider the key variables of United States energy supply and demand. Only by understanding the complex relationships among domestic production, consumption and imports can the current energy debate be transformed into an orderly assessment of future directions. ■

OIL-POOR DEVELOPING COUNTRIES

(*Continued from page 112*)

Excluding Afghanistan, which produces 2.85 billion cubic meters of natural gas [of which only 10 percent is consumed locally, with the rest exported to the Soviet Union], the other least developed states depended on imported energy to meet their requirements. Bangladesh and Rwanda, however, produce small amounts of natural gas, that are used locally. In addition, Afghanistan, Tanzania, and Botswana produce coal for local consumption. In 1974, Niger also produced an estimated 1,120 tons of uranium.[19]

Since 1973, the developing countries have been recipients of various forms of financial assistance from OPEC and multilateral agencies. Commitments, grants, loans and disbursements are among the measures that help the developing nations to compensate for the adverse effects of oil costs. In 1973, OPEC contributed $4,290 million, and in 1974, its commitments and disbursements amounted to $18,780 million. The "developed market" economies also extended financial aid (loans and grants) to the developing countries. Aid from this source rose from $13,323 million in 1973 to $19,146 million in 1974. From all sources, the least developed countries (excluding Haiti) received a total of $656,980 million in 1974.[20]

Since actual and potential increases in the price of oil influence the degree of economic activity in the developing states, numerous proposals have been under way to narrow the gap. During the 1974 Intergovernmental Meetings on the Impact of the Current Energy Crisis on the Economy of the ESCAP Region in Thailand, representatives of India, Iran, and others offered alternative approaches to the energy problem in the developing countries. India proposed a reduction of oil prices for these states; Iran advocated the creation of an international fund with a capital of $3 billion to support feasible projects in developing states, with contributions to be made equally by the OPEC and developed economies. India's proposal has gained credence recently among some OPEC members.

In short, the developing countries, many located in the tropics, have limited resources, especially water. A few of these countries rest on vast potential sources of energy, like oil and natural gas, as well as minerals. In most cases, however, the economic and commercial prospects of the developing countries remain dim, because virtually none of their known reserves can be developed quickly, easily, or profitably. Nevertheless, development of a few hydroelectric projects like those in Ghana and Zaire has offered abundant energy and has made possible the utilization of a variety of minerals, e.g., bauxite and copper. These hydroelectric installations, however, are exceptional.

The energy crisis has aggravated the chronic malaise of the nations of the developing world. It has made it more difficult for them to overcome old and new social, economic, and political problems. Unless substantial funds are forthcoming from abroad, their future will remain bleak. ■

[19] *Ibid.*, p. 19.

[20] United Nations, *World Economic Survey, 1975* (Publications Sales No. E.76.11C.1), p. 79; United Nations, *Handbook of International Trade and Development Statistics* (United Nations Publication Sales No. E.7.11.D.3), p. 320 and pp. 322-3; and Efrain Friedmann, *Financing Energy in Developing Countries* (World Bank Reprint Series, No. 27, reprinted from *Energy Policy*, March, 1976), p. 43.

SOVIET ENERGY RESOURCES AND PROSPECTS

(*Continued from page 120*)

largest in the world (28 trillion cubic meters in the $A+B+C_1$ categories) and should last 70 to 80 years (depending on the rate of recovery) at the current production level.[25] No reserve bottleneck, therefore, hampers rapid expansion, and the problems of the industry are due almost entirely to geography and the difficulties of transport.

As is true of oil, most gas fields west of the Urals

[25] *Geologiia, burenie i razrabotka gazovykh mestrozhdenii*, no. 4, 1977, p. 3. The recovery rate of gas is much higher than that of oil, varying in the U.S.S.R. from 80 to 90 percent of explored reserves of a deposit. *Gazovaia promyshlennost'*, no. 8, 1975, p. 4.

have peaked or are approaching exhaustion, and despite new discoveries the European U.S.S.R. today has less than one-fifth of all explored reserves. More than three-fifths of such reserves (by some accounts almost 70 percent) are concentrated in the permafrost-ridden wilderness of northwest Siberia and close to 15 percent are located in the deserts of Central Asia,[26] both 2,000 to 3,000 kilometers from the main urban-industrial concentrations of the European Soviet Union. In the Ukraine and the North Caucasus, which provided over 60 percent of all Soviet gas through much of the 1960's and more than half even in 1970, both reserves and output are declining, despite extensive drilling. Although two very large and several small fields were discovered elsewhere west of the Urals, the European U.S.S.R. contributed only one-fifth of the total increment in gas output between 1970 and the end of 1976, and its share declined from 70 percent to little over half of the Soviet total.[27]

The European U.S.S.R. must now look to the Asiatic provinces for an ever increasing share of its natural gas supplies. Today, the major eastern suppliers are the Muslim republics east of the Caspian Sea (Turkmenia, Uzbekistan and Kazakhstan), which send some 70 billion cubic meters, almost three-fourths of their total output, to the European U.S.S.R. and the Urals. However, production from these regions will soon approach its limit, while local demand in populous Central Asia is expected to grow significantly. Northwest Siberia, therefore, represents the sole reliable source of a future major increment.

Since a gas pipeline can transmit only about one-fifth of the calories carried by an oil pipeline of the same diameter, the transport problem presents far greater obstacles to rapid expansion of gas than of petroleum. To achieve the 1980 goals, 36,500 kilometers of gas pipelines, almost 30 percent of it from 48-inch and 56-inch pipes, will have to be built, and 300 compressor stations will have to be installed, as against 148 in the previous five year period.[28] To speed up the exploitation of Siberian reserves, the Soviet Union is prepared to barter large quantities of gas for pipes and compressor stations. It has signed a number of barter contracts with West European firms and has renewed negotiations with United States companies (now with European participation) on the $8 billion North Star project to export liquified methane (LNG) through the port of Murmansk.[29] The need for gas processing facilities (to remove sulfur and the heavier hydrocarbons before transportation) acts as a further brake on expansion. With the shift of petroleum production eastward, the share of oil well gases utilized has failed to increase, and two-fifths of all such gases released are still vented and flared.

The eastward and northward shift of production centers and the growing cost of maintaining output from older fields sharply raised the cost of production and the incremental need for capital in both the gas and oil industries. Between 1966 and 1972, production costs in the gas industry increased 4.6-fold. During 1970-1975, as compared to the previous five years, 60 percent more investment was required on production and transport to augment gas delivery by 1,000 cubic meters and 29 percent more investment to augment crude oil delivery (to refineries) by one ton.[30] With the growing distance between production and consumption centers, and the increasing importance of deep drilling, offshore exploration and tertiary recovery methods, the incremental productivity of capital is destined to decline even further in the next decade.

SOLID FUELS

Solid fuels were the mainstay of the Soviet energy economy throughout the Joseph Stalin years, contributing almost four-fifths of total production and consumption in 1950. The belated recognition of the economic effectiveness of oil and gas, coupled with much greater rationality in investment decisions for prospecting and exploration, has vastly expanded hydrocarbon reserves and the output of these quality fuels at the expense of coal, lignite, peat and shale. On an equal calorific basis, coal and lignite account for three-tenths of all energy production, and a third of consumption; peat, shale and firewood contribute under 3 percent, but

[26] Iu. Bokserman, "Puti povysheniia effektivnosti transporta toplivo," *Planovoe khoziaistvo*, no. 2, 1975, p. 21 and *Gazovaia promyshlennost'*, no. 8, 1975, p. 4 and *The Oil and Gas Journal*, April 14, 1975, p. 22. Half of all Soviet reserves are found in 6 super-giant fields, of which 4 are located in northwest Siberia, one in Central Asia and one in Orenburg Oblast of the European U.S.S.R. The Urengoi field in Siberia alone concentrates one-fifth of all explored reserves and is by far the largest gas field in the world discovered to date.

[27] Theodore Shabad, "News Notes," *Soviet Geography: Review and Translation*, April, 1977, p. 269.

[28] The Russians plan to import about 200 of these. *Business Week*, October 17, 1977, p. 52.

[29] From 1970 through 1976, almost 9 million tons of large diameter pipes, valued at $4.3 billion, were imported, mostly for the gas industry. Contracts were signed for the importation of all 22 compressor stations for the Orenburg-Uzhgorod gas line and 6 for the Urengoi-Cheliabinsk line, worth almost $1.2 billion, and for that of three gas processing plants for West Siberia. Offshore drilling near Sakhalin began recently in the joint Soviet-Japanese venture and the long discussed pact with Japan and the U.S. for the search of Iakut gas were also signed recently. This gas, if found, will go almost entirely for export through Pacific ports and will have little effect on the domestic energy situation. *The Oil and Gas Journal*, October 10, 1977, p. 110 and December 20, 1976, p. 23; *Journal of Commerce*, May 19, 1976; Moscow Narodny Bank, *Press Bulletin*, April 14, 1976, p. 8; April 28, 1976, p. 6; June 2, 1976, pp. 6-12; August 4, 1976, p. 7 and March 23, 1977, p. 6 and other sources.

[30] Lalaiants, *op. cit.*, p. 28. Costs in the gas industry, in fact, are rising faster than in any of the Soviet energy industries.

in a few areas of the U.S.S.R. their local role remains significant.

Since 1950, the production of coal (including lignite) has been growing much more slowly than oil and gas production, with the annual rate of expansion falling to 2.05 percent in the 1960's (a mere 1.5 percent when measured in calorific content). In the present decade, however, growth rates have picked up again, registering 2.35 percent per annum between 1970 and 1975, with planned rates of 2.8 percent for the coming 5 years. The U.S.S.R. has long been the world's leading coal producer, with a 1975 output of 701 million tons, which in hard coal (standard fuel) equivalent, however, adds up to only 490 million tons, rather less than the United States total. The revised 1980 plan calls for 805 million tons, but output is lagging badly and fulfillment of this goal is very unlikely.

Soviet coal reserves are vast, adequate for many hundreds of years. Faster growth in output is hindered by cost factors and capital needs, location and transport constraints and somewhat restricted markets and, to a lesser extent than in the United States, by environmental problems.

In the European U.S.S.R. and the Urals, demand far exceeds supply, and power stations alone could use far more coal than is available. In these regions, which produce half of all Soviet steam coal as well as coking coal and virtually all Soviet peat and shale, solid fuels cover only about one-fourth of all fuel consumption (48 percent in power stations, 33 percent under industrial boilers and, excepting coking coal needs and peat and firewood cut by rural households, virtually no other demand). Over the next decade, however, there is no chance to expand the output of coal in the European provinces by more than 40 million tons of SF equivalent (the output of all solid fuels by more than 50 million tons) and the 1976-1980 plan envisages a mere 10 million tons of increment.

The famed Donbas produced 224 million tons (89 million tons of coking coal, 135 million steam coal) in 1976, 31 percent of the Soviet total.[31] However, one-third of all production was to come from depths over 700 meters and, by 1980, two-fifths, with 80 percent originating from seams of less than 1.2 meters thick, and three-fifths of all reserves are in seams of less than 0.8 meters thick, which are not minable with existing technology. Much of the coal must still be extracted manually, and labor constraints are also serious.[32] Under these conditions, capacity increases for steam coal during the next 10 years will not exceed 30 million tons. Supplies from the smaller coal fields and from the shale and peat reserves of the European U.S.S.R. are capable of only limited expansion. Only the big Pechora Basin, equally difficult geologically and beyond the Arctic Circle, could physically furnish large increments and only after a very long lead time. Expansion in this basin is primarily for coking coal and will remain so.

Solid fuels produced west of the Urals are also expensive. With a 15 percent capital charge, coal costs at mine mouth approximate 17 rubles per ton of standard fuel for steam coal in the Donbas and reach 20 to 24 rubles in parts of the Pechora Basin and in the Moscow lignite field (with a 12 percent interest charge, costs are about one ruble lower). Shale and peat cost less, but their supplies are far more limited and they are not transportable. Therefore, virtually everywhere west of the Volga, the delivered cost of solid fuels per ton of SF is above 18 rubles. Fuel oil today delivered to market centers costs half that much, and natural gas from deposits in the European provinces costs only a fraction of that total. Even Siberian and Central Asian gas, piped in from 2,500-3,500 kilometers, can be delivered several rubles cheaper than coal from any of the European deposits. With such a difference between the marginal costs of different fuels, all European regions could reap large savings by a more rapid and intensive substitution of gas and oil. However, the drastic rise in the export prices of oil and gas and the growing needs of East Europe have slowed the pressure to substitute these fuels for coal, even in the European U.S.S.R.

The most economic coal resources (and those capable of the greatest expansion) are all found east of the Urals, with the Kuzbas and Kansk-Achinsk Basin in Siberia and Ekibastuz in northeast Kazakhstan the most important. Most of these deposits easily lend themselves to strip mining, and the two latter areas can produce energy at a cost lower than all oil fields and virtually all natural gas reservoirs in the country.[33] Most of the cheap surface coals of Siberia and Kazakhstan, however, are of too poor quality to serve for anything but boiler—primarily power station—fuel and are transportable for only short distances. Kansk-Achinsk lignite does not yield easily to briquetting and is liable to self-combustion, while the high ash content of Ekibastuz coal prevents its haulage beyond the western slopes of the Urals. Of all eastern coals, only Kuzbas coal can be moved west of the Volga, doubling in cost by the time it reaches Moscow.

To the chagrin of pro-Siberian planners, the development of the vast Kansk-Achinsk deposit has so far proceeded very slowly, with production reaching only 30 million tons (15 million to 16 million tons of SF). Not only is the local market restricted, but power station use for this lignite is further limited by the availability of

[31] T. Shabad, *Soviet Geography,* April, 1977, p. 264.

[32] In the central part of the Donbas, where most of the coking coal originates, 70 percent of the coal is still extracted with pneumatic drills. The 1974 plan was fulfilled only by having half a million miners work through most weekends and holidays in actual violation of the labor code.

[33] Yearly output in the Kansk-Achinsk basin could allegedly be raised to 580 million tons (2.8 times more than all strip mined output in the U.S.S.R. today), representing 240 to 300 million tons of SF, with virtually no increase in cost from worsening geological conditions.

very cheap and abundant hydroelectricity in the region, with large potentials still untapped. Current research has begun to focus on the enrichment and briquetting of this lignite to permit large-scale transportation at least to the Kuzbas and eventually to the Urals and beyond. Even in the Urals, Kansk-Achinsk coal would be competitive with most other forms of energy, and the move would also free Kuzbas coal (and even some fuel oil) to energy-deficit regions in the European U.S.S.R.[34] Breakthroughs in the cost of very long distance electric power transport and coal slurry pipelines would also expand the range of Kansk-Achinsk lignite.

While an eventual solution to the massive use of these vast reserves is imperative for the Soviet energy economy, until the early 1980's primary emphasis is being placed on the maximum exploitation of the Ekibastuz field and the faster development of strip mining in the Kuzbas. Very cheap to mine and located only 1,100 kilometers east of the Urals, Ekibastuz coal can compete effectively as power station fuel even with Siberian and Central Asian gas or fuel oil as far west as the River Volga. Its energy can also be transmitted to the Urals economically via alternating current, using existing transmission technology. With 52 million tons of strip mining capacity today, almost one-fourth of the Soviet total, the basin's output is slated to grow by another 20 million tons in five years, and to exceed 100 million tons during the 1980's. A major effort seems to be under way to substitute this fuel for oil and gas under large power station boilers in the Urals and even in the Volga regions. Production in the Kuzbas should increase by almost 30 million tons, to reach 161 million tons by 1980; it may approach 200 million tons by the end of that decade. Over two-fifths of the basin's output is coking coal and will remain so. Ekibastuz, the Kuzbas and the Kansk-Achinsk Basin will account for roughly two-thirds of all increment in coal production between 1975 and 1980 and more afterward. Most of the rest will also come from fields east of the Urals. These expansions will further raise the share of open pit methods in coal production, currently providing three-tenths of the Soviet total.

HYDRO AND NUCLEAR POWER

The importance of primary electricity in total energy supply should not be overestimated, even in countries with mainly hydro-based generating capacity or rapid nuclear development. In the U.S.S.R., ideological bias, a penchant for hugeness and a long-term distorted view of capital in project selection have tended to favor capital-intensive hydroelectric plants, whose operating costs are generally low. Not counting outlays on transmission and distribution, hydroelectric stations received more than half of all investment in the electric power industry during the 1950's and accounted for almost two-fifths of the value of new fixed assets from 1959 to 1965. Yet for only a few brief years in the late 1950's and early 1960's did they account for more than 20 percent of the total installed capacity, and they never accounted for that much of total production. Even including the Caucasus, the European U.S.S.R. produced a mere 8 percent of electricity at hydrostations in 1975. By contrast, in the Asiatic part of the country, 18 percent of all electric power was generated by hydroplants,[35] with East Siberia standing out with an exceptionally high share, reaching three-fifths at the beginning of the 1970's. The contribution of hydroelectricity to total energy supplies, therefore, was a mere 2 percent in the European provinces and remained under 5 percent even in the Asiatic U.S.S.R. as a whole.

In assessing the future role of hydropower, it is essential to realize that, west of and inclusive of the Urals, close to half the economically exploitable power capacity is already installed or under construction. Much of the rest is sorely needed for peaking, and the present capacity, too, may have to be devoted increasingly to that purpose. In addition, the multipurpose use of water basin schemes has meant that substantially less water is available for power generation than was originally projected. In 1970, the capacity factor (i.e., the percent of availability of power) of all hydrostations in the European U.S.S.R. reached less than 45 as against more than 54 in the Asiatic part of the country, with the difference doubtless increasing.

The Asiatic Soviet Union boasts enormous, unexploited water power potential. Yet about 55 percent of this stated potential is located north of latitude 60°, where a population of only two million is scattered over an area as large as the United States in a forbidding region with continuous permafrost, where river runoff is extremely irregular, and where technology and construction experience from more southerly provinces do not suffice. Another 6 to 7 percent is represented by the Amur River, whose full utilization is precluded by tensions in Sino-Soviet relations, restricting development to some of its tributaries. The remainder, however, still amounts to a 35 million to 38 million kilowatt potential installed capacity in Siberia and roughly the same in Central Asia. In the Siberian provinces, about 30 percent of this accessible potential is being exploited, and projects already under construction should bring this share close to 60 percent. Less than one-fifth of the Central Asian potential is utilized or is in the process of development; irrigation and flood control, more than power generation, provide the primary rationale.

Only in East Siberia, and to a lesser extent in Central Asia, will hydroelectric stations continue to maintain their prominent role in electric power supply. Elsewhere, their share should decline rapidly in the forth-

[34] However, the redesigning of boilers to enable plants to switch from high quality Kuzbas coal to inferior Kansk-Achinsk and Ekibastuz ones will be a costly undertaking.

[35] Computed from Nekrasov and Pervukhin, *op. cit.*, p. 141 and T. Shabad, *Soviet Geography*, April, 1977, p. 272.

coming years. Multipurpose uses and the need for peak power will reduce hydro's contribution in the country's electricity output to well below one-tenth. One source estimates that in the European U.S.S.R., hydroplants, on the average, will be utilized for only about 2,000 hours per year (23 percent of the time) and in the Asiatic U.S.S.R., for about 4,000.

At the end of 1975, Soviet nuclear capacity reached 4.7 million kilowatts, 2.2 percent of all installed generating capacity and less than one-fifth of the capacity of installed American reactors.[36] East of the Urals, abundant low cost coal and highly favorable hydroelectric sites have obviated the need for the nuclear alternative, at least in this century, but atomic electricity has become attractive throughout the European Soviet Union. Although investment per KW capacity is significantly higher for nuclear stations, the total cost per kilowatt-hour, inclusive of interest charges, is reportedly below that of conventional thermal plants burning any kind of fuel west of the Volga. In the 1970-1975 period, atomic stations contributed some 11 percent of the increment to generating capacity in the European U.S.S.R. and will contribute over one-third in the forthcoming 10 years. The ambitious goal of 18.4 million KW of nuclear capacity by 1980 may not be fully realized, but such capacity should exceed 30 million KW by the mid-1980's.[37] The newest Soviet reactors of the water-cooled, graphite-moderated channel type have capacities of 1,000 megawatts. After a recent visit, leading British engineers in the field declared themselves deeply impressed by Soviet reactor technology.[38] The lead time for the commissioning of atomic plants in the U.S.S.R. seems to be much shorter than it is in the United States, and the confidence in the future of nuclear energy appears genuine.

It is important, however, to put the amount of fuel saved by the nuclear program into perspective. The 20.2 billion KWH of nuclear electricity produced in 1975, saved less than 7 million tons of standard fuel. Only some 70 million tons will be saved under the best of circumstances by 1985,[39] representing 12 percent of projected power station demand and 3 to 4 percent of total energy consumption west of the Urals.[40] Apparently, Soviet leaders find it difficult to accelerate nuclear construction greatly, and atomic power cannot be expected to solve the country's energy problems in the next two decades.

Whatever the precise relationship between economic development and the control and use of energy may be, the mobilization of energy resources provides a vital underpinning of a country's economic and military strength. In contrast to the erratic record of Western powers, Soviet planners win relatively high marks for the long-range, purposeful and usually sound development and management of their energy resources. A comprehensive energy policy demands complex, interconnected decisions on investment alternatives, fuel substitution and intersectoral and regional allocation to maximize overall advantage, which includes the opportunity cost of fuels on the export market. However, the long lead times and multiplying investment needs, combined with very incomplete economic data, mean enormously difficult technical-economic choices for energy planners who know that their decisions will not be easily reversible. Within the framework of the 1976-1980 five year plan, a comprehensive Soviet energy policy is clearly discernible. Yet, the much touted fifteen year plan (1976-1990) for the fuel industries has not yet been adopted or apparently even prepared in sufficient detail. Instead, Soviet planning organs today seem engaged in an ongoing and crucial energy debate, with the experts often sharply divided. The controversy and lobbying between ministries, institutions and regional interest groups appear more intense than at any time in the post-Stalin years, particularly with respect to hydrocarbons and the development of Siberian lignites.[41]

Soviet energy reserves are vast, but they are not cheap. Their exploitation demands very long lead times and an even larger share of the nation's capital and manpower resources, material products and research effort. The U.S.S.R., with some East European assistance, is able to develop its resources alone. To gain time, however, Soviet leaders are ready to welcome Western and Japanese participation (though not ownership) on a large scale. For natural gas and coal (though not for oil) deliveries they are willing to make long-term commitments, and to some extent they have already done so. But the mounting anxiety over resources among Western industrial powers has not been lost on Soviet leaders. In addition, the Soviet energy sector, particularly the petroleum industry, is also beset with significant problems. Soviet planners, therefore, are expected to place increasing value on their energy and other mineral riches and to keep the long-term goals of national security, self-sufficiency and full control over supplies foremost in their development plans. ■

[36]Nekrasov and Pervukhin, *op. cit.*, p. 61. Early 1977 nuclear capacity is reported to reach 7 million KW. Seven of the nuclear plants are designed to reach or exceed one million KW each, and four of these two million KW each, by 1980. *Izvestiia*, May 25, 1977, p. 4.

[37]Nekrasov and Pervukhin, *op. cit.*, pp. 110-112 and *Ekonomicheskaia gazeta,* no. 9, February, 1976, p. 24 for capacity of European grid.

[38]*Financial Times* (London), November 7, 1975. and Pervukhin, *op. cit.*, p. 61.

[39]With heat rates of 325 grams of SF per KWH in 1975 and 315 grams in 1985 and a 65-66 percent availability in 1975 and 70 percent in 1985. The 1980 plan is 325-328 grams. *Ekonomicheskaia gazeta,* no. 9, February, 1976, p. 24.

[40]In 1975, the Unified European Grid had a capacity of 150 million KW, with a planned capacity of 230 million KW in 1980. *Ekonomicheskaia gazeta,* no. 9, February, 1976, p. 24.

[41]The author has examined this debate in "The Soviet Union: An Energy Crunch Ahead?" *Problems of Communism,* September-October, 1977, pp. 41-60.

EUROPEAN AND JAPANESE ENERGY POLICIES

(*Continued from page 129*)

brings together France, Italy, Belgium, Spain and Sweden, and URENCO, in which the United Kingdom, West Germany and the Netherlands collaborate.[26] The EC has been unable to impose a common approach to this particular technical problem, while Eurodif has brought in countries like Spain and Sweden that are not even members of the Communities.

Increasingly, no national program, nor even the program of a regional body like the EC, will set the pace in energy research and development (R&D). Rather, the IEA is emerging as the key actor in the international arena. This body plays an active role as "marriage broker" in energy research, designating which countries should lead international research efforts in which energy technologies, keeping tabs on the growing number of R&D pacts signed by its members (28 at the last count)[27] and is just starting to vet the research strategies of its 19 member states along the lines of the OECD "program reviews" in the economic field.[28] In the long run, all the OECD members will have to develop their energy policies within the context of a continuing and constructive dialogue with the International Energy Agency. This is not to argue that the energy problems of the various regions will become the same (obviously, Japan's will remain acute), but that it is increasingly senseless to look at the search for technological solutions on a national or even regional basis. Technology diffuses so rapidly these days that a strictly nationalist approach is self-defeating. ■

[26]Frans A. M. Alting von Geusau, *Energy in the European Communities* (Leyden: A. W. Sijthoff, 1975), p. 129.
[27]*Petroleum Intelligence Weekly*, October 24, 1977, p. 9.
[28]Turner and Parry, *op. cit.*

CHINA'S ENERGY RESOURCES

(*Continued from page 124*)

for industrial production per productive worker in the petroleum industry were more than five times those of the coal industry.[15] This official information implies a lack of capital investment in the coal industry and perhaps explains why the government relies on small locally run mines instead of developing large-scale major shafts. In 1973, small mines are said to have produced 28 percent of the total coal.[16] It seems probable that they have produced between 25 and 30 percent of the total output since that time. In Tibet, for example, small mines account for all the coal produced in 1975. In Kwangtung and Yunnan, they accounted for 50 percent of the coal output. Even in China's leading coal-producing province of Shansi, small mines produced 40 percent of the 1975 output.[17]

The development of small coal mines is not without advantages. They are easily and quickly opened at relatively small capital expense. However, their readily accessible coal deposits are frequently exhausted in a short period of time. In contrast, new large-scale mines with deep shafts are expensive and time-consuming to build, but they are usually productive for a long period of time. By relying on small mines, the Chinese government opted for a short-term solution to a long-term problem.

RECENT PERFORMANCE

Performance of the Chinese energy industries during the past 3 years (1975-77) has been very erratic. The frequent change of developmental policies and the recurring power struggles within the party's top hierarchy exerted profound impact on all industries; coal, electric power, and steel suffered the most.

In 1974, the campaign to criticize Lin Piao and Confucius had a disruptive effect on coal supplies. The "Central Document 21," issued by the Communist party's Central Committee in midyear 1974, admitted that coal production for the first five months of 1974 had fallen below target by 8.35 million tons.[18] Coal production for 1974 suffered the deepest setback. Its growth rate was estimated by United States government Sinologists at only 3 to 4 percent. In that year, coal was in short supply and was even described officially as a major bottleneck in the economy.[19]

In January, 1975, after Premier Chou En-lai proclaimed the ambitious program to modernize the country's agriculture, industry, national defense, and science and technology before the year 2000, Chinese planners apparently revised their developmental priorities. In that month, the Ministry of Coal Industry was reestablished; formerly it was only a division of the Ministry of the Coal, Petroleum, and Chemical Industries. In October and November, 1975, in Peking, a National Coal Conference was attended by more than 5,000 cadres, workers, technicians and researchers in the coal industry. At the conference, a 10-year program for China's coal industry was developed, and a 4-point plan to boost coal production was announced.[20]

During the first half of 1975, 22 pairs of coal shafts had been reportedly completed. A new major coal mining center has been established in Southern Szechwan. Two important rail lines have been opened in the Szechwan, Yunnan and Kweichow region, an area which has been a source of little coal mining in the past. All these developments indicated that the Chinese government has opened new coal mines in the South-

[15]Nai-ruenn Ch'en, *op. cit.*, pp. 150-151.
[16]*Chung-kung Yen-chiu* [Studies on Chinese Communism] (Taipei), vol. 10, no. 1 (January, 1976), p. 44.
[17]NCNA (Peking), January 26, 1976.
[18]U.S. Central Intelligence Agency, *China: Energy Balance Projection* (Washington, D.C., 1975), p. 3.
[19]*Current Scene* (Hong Kong), May, 1976, p. 12.
[20]*Jen-min Jih-pao* [People's Daily], November 1, 1975.

west region, in an effort to alter the regional source of energy distribution. The result was a healthy increase in coal production in 1975. Output that year jumped by nearly 10 percent over 1974 to reach 427 million tons, the largest annual increase in five years.[21]

The surge in coal production continued into the first half of 1976. Midyear official reports showed an increase of 7.6 percent.[22] However, as the political movement to criticize Teng Hsiao-p'ing, then the acting Premier, intensified, the output of coal began to slow down. Earthquake damage to the K'ai-luan coal mines in late July also accounted for part of the skid in output in 1976. For years, K'ai-luan was China's largest coal producing center, supplying more than 6 percent of the national output in 1975. The severe damage in K'ai-luan may have reduced the national growth rate in coal production by 2 to 3 percent.[23] Chinese coal production in 1976 was estimated by United States government experts at 448 million tons, an increase of only 5 percent. In relative terms, the 1976 coal production in China amounted to 68 percent of United States output and 70 percent of U.S.S.R. output in the same year.

After the death of China's Chairman Mao Tse-tung and the disgrace of the radical "Gang of Four" in October, 1976, the new regime led by Hua Kuo-feng seemed to turn pragmatic. The industrial development goals set by Chou in early 1975 were again proclaimed. In early 1977, a national coal industry conference to learn from the Taching oilfield and to catch up with the K'ai-luan coal mines was held in Peking. At this meeting, a nationwide emulation drive in the coal industry was proposed. Official reports in late September indicated that coal output maintained an "upward trend."[24] Since no production increase over 1976 was claimed, the growth rate may not have been great.

PETROLEUM

Political instability also affected petroleum production. China's petroleum output continued to grow in 1975. Under the influence of Deputy Prime Minister Teng Hsiao-p'ing, a program to increase crude oil exports in exchange for foreign machinery and equipment was implemented. To achieve this goal, the Taching-Chinwangtao pipeline was extended to Peking in June, 1975. The construction of a second pipeline in the northeast area, paralleling the northernmost segment of the first and terminating at T'ieh-ling in Liaoning Province, was completed by October, 1974. In December, 1975, this line was extended to the port of Dairen.[25]

The completion of these major pipelines facilitated the efficient transportation of oil between Northeast and North China. Crude oil output in 1975 was officially reported as having increased by 20 percent over 1974,[26] thus raising the estimate of Chinese crude oil output for 1975 to 75 million tons. Official reports also revealed that a new oil field has been constructed in North China.[27] Japanese sources indicated that the new major oilfield is located 125 miles northeast of Peking. China's total crude oil exports in 1975 reached 10 million tons. In early 1976, Teng's policy was condemned by the radicals as "a policy of capitulation and national betrayal."[28] Since the downfall of Teng in February, 1976, China has returned to the principle of self-reliance. The import of foreign equipment was drastically curtailed, and the growth rate of crude oil output began to scale down. During the 1973-1975 period, the average annual growth rate of crude oil was 20 percent. Yet in 1976, the growth rate of crude oil was only 13 percent.[29] The slowdown continued in the first 11 months of 1977, when crude oil output achieved only an 8 percent increase over the corresponding period in 1976, representing the lowest growth in a decade.[30]

The purge of the radicals in October, 1976, brought the petroleum industry back to the limelight. The policy of exporting crude oil in exchange for foreign equipment and technology, which was once condemned by the "Gang of Four," is now confirmed by the new leaders as a sound policy approved by Mao himself. In April and May, 1977, a national industrial conference on "Learning from Taching" was first convened in Taching and then continued in Peking. At this 7,000-representative conference, Prime Minister Hua Kuo-feng issued a call to build more than 10 more major oilfields similar to Taching in scale in the present century.[31] Official reports in recent months reveal that several new oilfields are being developed in South Liaoning, Northeast China; in North Hopei, North China; in Kwantung and Hunan, South China; and in Hupei, Central China. Surprisingly, in early December, 1977, official information disclosed that China's crude oil output in 1977 increased 72 times over that of 1957.[32] Since the 1957 crude output was officially reported as 1.46 million tons, the 1977 output would amount to 106 million tons, representing an increase of 25 percent over the 1976 record. However, since this latest figure is not dovetailed with the 8 percent rise officially reported for the first 11 months, its validity is highly questionable.

[21] U.S. Central Intelligence Agency, *China, the Coal Industry*, November, 1976, p. 6.
[22] NCNA, July 12, 1976.
[23] *Current Scene*, vol. 15, no. 2 (February, 1977), p. 16.
[24] NCNA, September 28, 1977.
[25] *Ibid.*, December 5, 1975.
[26] *Ta-Kung pao* (Hong Kong), December 1, 1975.
[27] NCNA, January 3, 1977.
[28] *Peking Review*, August 27, 1976.
[29] NCNA, January 3, 1977.
[30] *Ibid.*, December 23, 1977.
[31] *Jen-min Jih-pao*, May 8, 1977.
[32] *China Daily News* (New York), December 8, 1977. It quoted the source as an article published in *Kuang-ming Jih-pao* in Peking.

As of December, 1977, the energy supply picture of the People's Republic of China in intermediate terms appears not so rosy as the projections made two years ago. The slowdown of crude oil output in recent years caused oil exports to decline from 10 million tons in 1975 to 8 million tons in 1976 and to 7 million tons in 1977. A shortage of coal and electricty was widespread and became a constraint to industrial growth. Yu Chiu-li, Vice Premier and head of China's state planning commission, told the latest session of the Standing Committee of the National People's Congress on October 23, 1977, that supplies of fuel and electricity still could not keep up with the pace of domestic economic growth.[33]

LONG-TERM PROSPECTS

The long-term prospect of China as a major energy exporter also became obscure. The foremost problem in developing China's energy industries is the lack of capital. Although China possesses adequate energy resources, her extraction capacity and transportation facilities are still inadequate. In the past decade, there was a keen competition for the scarce capital between petroleum and other fuel industries. The diversion of capital to oil development has been accomplished at the expense of investment in coal and electrical power. In recent years, an attempt to reallocate capital investment from oil to coal and electric power industries immediately dampened the growth of the petroleum industry. The most promising oil resources in China, lying offshore on the continental shelf, will require tremendous outlays to the foreign companies that make and supply the massive drilling rigs and sophisticated equipment necessary to extract large quantities of oil from this area. On the other hand, extraction of the rich deposits inland requires the construction of many thousands of miles of pipeline. Either route will require huge amounts of capital expenditures.

China's capacity to obtain foreign equipment is limited by her exports. In the 1973-1975 period, the importation of $2 billion worth of foreign equipment resulted in a huge trade deficit. By the end of 1976, China had foreign repayment obligations of $1.3 billion, which amounted to 23 percent of her total hard currency earnings with the non-Communist world in 1976.[34] Consequently, China was compelled to curtail drastically the procurement of foreign petro-equipment in 1976 and 1977. The lack of steel pipes and tubes for oil well drilling also became one major drag for oil development.[35] Unless China is willing to forego her policy of self-reliance and to allow foreign oil companies to exploit offshore resources jointly, the growth rate of oil production in China will decelerate in the years ahead. ■

[33]NCNA, October 24, 1977.
[34]*The New York Times,* November 2, 1977.
[35]*The Seventies* (Hong Kong), July, 1977, p. 21.

OPEC: ISSUES OF SUPPLY AND DEMAND

(*Continued from page 127*)

proved reserves of the United States. This sparsely populated desert country suffers from severe absorptive capacity constraints; hence its massive reserves of capital funds. Saudi Arabia can alter output with relative ease, particularly in cutbacks, without any negative impact on her level of domestic economic activity.

Considering these circumstances, what incentives are there (and should there be) to encourage Saudi Arabia and the other "low absorbers" like Kuwait, Qatar, and the United Arab Emirates to continue and to raise production in the coming decade and a half?

INTERNATIONAL COOPERATION

Two inescapable energy facts confront the world. While oil reserves are being depleted rapidly, no short-term relief through alternative energy sources is forthcoming. Second, in addition, the substitution cost for oil remains substantially higher than the price of petroleum. The comparatively low price of oil has actually dampened efforts toward conservation in consumption and toward the expansion of other energy supplies that are not yet competitive with petroleum. Given the influence of time and economics in the global energy perspective and given the wide geographical dispersion of resources, technology, and capital, international cooperation is the only rational approach.

Despite domestic pressure for conservation of output, OPEC members have met world demand for the past four years. Since the abrupt increases announced in 1973 and 1974, OPEC price adjustments have been moderate. Yet even with the higher price of OPEC oil, in most cases the importing countries have resumed their consumption habits and trends, surpassing the pre-embargo levels of 1973.

The major producing nations face special economic and development problems. Many suffer from severely limited diversification possibilities, sweeping reliance on a single, nonrenewable, export-oriented commodity (oil), and difficulties in transferring their capital funds into actual capital formation (i.e., income-generating domestic and foreign investment).

Aside from the demand-supply linkage, OPEC and the industrialized nations have other common interests: development of nonpetroleum energy resources for the "oil-less" days ahead; mutual efforts to stimulate economic growth in the non-oil developing nations; the transfer of technology; averting international monetary disorder. Interaction between oil-generated capital funds from OPEC members and advanced technology from the advanced countries is critical to a smooth energy transition for the world in the years ahead. ■

THE MONTH IN REVIEW

A Current History chronology covering the most important events of January, 1978, to provide a day-by-day summary of world affairs.

INTERNATIONAL

East African Community

Jan. 14—Kenya, Uganda and Tanzania, the members of the East African Community that ceased to function in 1976, have chosen a United Nations official as a mediator to help them divide the assets and liabilities of the Community.

Middle East

(See also *Intl, U.N.; U.S., Foreign Policy*)

Jan. 1—In an interview in *October Magazine*, Egyptian President Anwar Sadat says that U.S. President Jimmy Carter's statement that he does not favor the establishment of a "fairly radical new independent" Palestinian state "will create severe difficulties in the negotiations" between Israel and Egypt.

Jan. 3—Israeli Prime Minister Menahem Begin asks President Sadat "not to issue calls for the imposition of [U.S.] pressure upon Israel"; he declares that he "never asked the government of the United States to impose pressure on Egypt."

Jan. 4—After today's meeting between President Carter and President Sadat in Aswan, Begin says that Israel "shall not agree to such a mortal danger" as the establishment of a "Palestinian state."

Jan. 11—Israel and Egypt begin talks in Cairo on the military aspects of a Middle East settlement; a "military committee," headed by the defense ministers of Israel and Egypt, is to work out details of Israeli withdrawal from the Sinai and a system of security safeguards for both countries.

Jan. 13—Israeli-Egyptian military talks in Cairo recess after 2 days.

Jan. 15—After delaying his departure from Washington, D.C., by a day, U.S. Secretary of State Cyrus Vance flies to Israel to offer compromise suggestions to Israel and Egypt to overcome stalled negotiations. Israel and Egypt accept the wording of the U.S.-proposed compromise.

Jan. 17—With U.S. Secretary of State Cyrus Vance attending, Egyptian Foreign Minister Ibrahim Kamel and Israeli Foreign Minister Moshe Dayan meet in Jerusalem for political negotiations.

Jan. 18—President Sadat recalls the Egyptian delegation from the Jerusalem political talks, until Israel changes her position on a Palestinian state.

Jan. 20—In Cairo, U.S. Secretary of State Cyrus Vance is unable to persuade Sadat to send his negotiators back to the interrupted peace negotiations in Jerusalem.

Jan. 21—In a speech to the Egyptian Parliament, President Sadat pledges to continue to try to negotiate a peace settlement with Israel despite the stalled negotiations.

Jan. 23—In Jerusalem, Israeli Prime Minister Begin says the Israeli delegates to the military committee in Cairo will not return to Cairo until the Egyptian press ceases its "hatred and incitement to hatred against the Jewish people."

Jan. 29—By a unanimous vote, the Israeli Cabinet agrees to resume participation in the Israeli-Egyptian military committee negotiations in Cairo.

Jan. 31—The Israeli press reports that 3 new military outposts in the occupied West Bank will become Israeli civilian settlements.

In Cairo, the Israeli-Egyptian military committee negotiations resume.

North Atlantic Treaty Organization (NATO)

(See *U.S., Foreign Policy*)

Science and Space

(See also *U.S.S.R.*)

Jan. 24—A Soviet spy satellite, the Cosmos 954, falls from orbit and disintegrates over northwestern Canada; the satellite carried a nuclear reactor.

Jan. 28—Possible radioactive debris from Cosmos 954 is reported from Warden's Grove in northwest Canada.

Jan. 30—Canadian and U.S. scientists report that debris found near Warden's Grove came from Cosmos 954 and is radioactive.

United Nations

(See also *Middle East*)

Jan. 3—The United Nations Food and Agriculture Organization concludes a 3-week biennial conference in Rome; delegates from 144 countries conclude that there has been little progress toward eradicating hunger and poor nutrition in the last 3 years.

Jan. 11—Secretary General Kurt Waldheim says that he will not attend the Israeli-Egyptian peace talks in Jerusalem.

ARGENTINA

Jan. 25—Foreign Minister Vice Admiral Oscar Montes announces the government's rejection of an international arbitration committee's decision to award 3 islands in Tierra del Fuego to Chile. The government will not attempt to take military possession of the islands.

BELGIUM

(See *France*)

BRAZIL

Jan. 5—In Brasilia, President Ernesto Geisel designates General João Baptista de Oliveira Figueiredo, head of the National Intelligence Service, as his successor when Geisel retires in March, 1979.

BURMA

(See *China*)

CAMBODIA

(See also *China*)

Jan. 1—Following Cambodia's action in breaking off diplomatic relations with Vietnam yesterday, Vietnamese officials accuse Cambodia of attacking and occupying

Vietnamese territory along their joint border in Vietnam's Tay Ninh Province (the Parrot's Beak). Vietnam reportedly has nearly 60,000 troops in the Cambodian province of Svay Rieng.

Jan. 8—In a televised interview in the United States, U.S. national security adviser Zbigniew Brzezinski says that the border conflict between Vietnam and Cambodia is really a "proxy war" between China and the Soviet Union, with Vietnam receiving support from the U.S.S.R. and Cambodia receiving aid from China.

Jan. 20—In Hanoi, Hanoi Radio broadcasts an editorial declaring that "We cannot help but to resort to legitimate self-defense . . ." if Cambodian raids on Vietnam continue.

Jan. 28—Cambodian forces continue their attack on Tay Ninh province.

Jan. 30—Phnom Penh radio reports that all invading Vietnamese troops have been chased from Cambodian territory.

Thai Foreign Minister Uppadhit Pajjariyangkul flies to Cambodia to discuss the establishment of normal diplomatic relations with Cambodian diplomats.

CANADA

(See also *Intl, Science and Space*)

Jan. 10—In Ottawa, Statistics Canada, the official information agency, reports unemployment for December, 1977, at 8.5 percent, the highest rate since the Great Depression.

Jan. 17—In Ottawa, U.S. Vice President Walter Mondale meets with Prime Minister Pierre Elliott Trudeau for discussions on sharing energy resources.

Jan. 24—In Montreal, Superior Court Chief Justice Jules Deschenes rules that a section of the recently enacted language law which makes French the language of the courts in Quebec is unconstitutional.

Prime Minister Trudeau is informed by U.S. President Jimmy Carter that a Soviet nuclear-powered satellite has disintegrated and crashed in a remote area of northwestern Canada.

CHILE

(See also *Argentina*)

Jan. 4—A nationwide plebiscite is held to determine whether Chileans support the regime of President Augusto Pinochet Ugarte.

In Geneva, the International Commission of Jurists issues a report stating that in Chile "the whole structure of repression and the suspension of basic rights and fundamental freedoms remain unchanged."

Jan. 5—An Interior Ministry spokesman reports that 75 percent of those voting in yesterday's plebiscite support the policies of President Pinochet, despite international criticism of his human rights policies.

Pinochet says that he will issue a new constitution without voter approval to establish an "authoritarian democracy."

Jan. 30—It is reported from Santiago that last week a federal court acted to limit the government's punitive power when it ruled that the government must transfer 12 political prisoners from a remote mountain village to an Arica hotel.

CHINA

(See also *Cambodia*)

Jan. 18—Hsinhua, the government press agency, reports that Teng Ying-chiao, Chou En-lai's widow, has left Peking for Phnom Penh in a show of support for Cambodia in her border dispute with Vietnam.

Jan. 26—Deputy Prime Minister Teng Hsiao-ping arrives in Rangoon, Burma, on the first foreign trip by a Chinese leader since 1975.

EGYPT

(See also *Intl, Middle East; U.S., Foreign Policy*)

Jan. 4—In Aswan, U.S. President Jimmy Carter meets with President Anwar Sadat.

ETHIOPIA

(See also *Somalia*)

Jan. 12—In Washington, D.C., U.S. President Jimmy Carter criticizes the Soviet Union for its military support of Ethiopian forces against the Western Somali Liberation Front in the disputed area of Ogaden province.

Jan. 18—Ethiopian Major Birhanu Baye, a member of the Provisional Military Administrative Council, denies that there are any Soviet or Cuban troops or military advisers in Ethiopia. U.S. officials recently estimated that there are 2,000 Cuban and 1,000 Soviet military advisers in Ethiopia.

Jan. 21—Representatives from the U.S., Britain, France, West Germany and Italy meet in Washington, D.C., to discuss the fighting between Somalis and Ethiopians in the Ogaden region of Ethiopia.

Jan. 22—Addis Ababa radio reports that West German ambassador Johann Christian Lankes has been expelled, apparently in retaliation for West Germany's $11.8 million grant to Somalia.

FINLAND

Jan. 15—2-day nationwide presidential elections are held.

Jan. 16—Late election returns indicate that President Urho Kekkonen received 83.7 percent of the vote. This is the 1st presidential election held in 10 years.

FRANCE

Jan. 4—U.S. President Jimmy Carter arrives in Paris for a 3-day visit with French officials. He meets with French President Valéry Giscard d'Estaing.

Jan. 6—In Paris, President Carter meets with French Socialist leader François Mitterand. Carter reportedly warns the Socialists against renewing their alliance with the Communists in the upcoming election.

Jan. 9—A Foreign Ministry spokesman says the government is attempting to assure contractual safeguards against the development of plutonium in the sale of a nuclear reprocessing plant to Pakistan.

Jan. 11—President Valéry Giscard d'Estaing arrives in Abijan, Ivory Coast, for a 4-day visit.

Jan. 23—In Paris, a Belgian industrialist, Baron Edouard-Jean Empain, is kidnapped by terrorists.

Jan. 24—Terrorists belonging to the Maoist Armed Cell for Popular Autonomy claim responsibility for Empain's kidnapping; they are demanding the release of terrorists held in West German and French prisons in exchange for his safe return.

Jan. 25—President Giscard proposes the creation of an international satellite system to oversee the movement of arms around the world. The proposal is seen as an attempt on the part of the French government to take part in arms control negotiations.

Jan. 26—Kidnappers of Belgian industrialist Baron Empain demand millions of dollars in ransom for his release.

GERMANY, WEST

(See *Ethiopia; Somalia*)

GREECE

Jan. 21—In Athens, U.S. Secretary of State Cyrus R. Vance arrives for talks with Prime Minister Constantine Caramanlis.

HUNGARY

Jan. 6—In Budapest, U.S. Secretary of State Cryus R. Vance officially returns the Crown of St. Stephen to government officials. The crown is accepted by president of the National Assembly Antal Apro.

INDIA

Jan. 1—In New Delhi, U.S. President Jimmy Carter meets with Prime Minister Morarji R. Desai.

Former Prime Minister Indira Gandhi opens a 2-day conference of loyal Congress party members in defiance of Congress party leaders.

Jan. 2—Gandhi's supporters in the Congress party officially sever ties with the party and establish a 3d political party, also called the Congress party.

In New Delhi, President Carter addresses a special session of the Parliament; he says that "shipments of nuclear fuel" will be made as promised for a nuclear power reactor.

Jan. 3—The Congress party votes to expel Indira Gandhi from membership.

Jan. 7—British Prime Minister James Callaghan arrives in New Delhi for a week-long visit.

Jan. 9—Gandhi appears before a judicial commission that is investigating government practices during her administration.

Jan. 19—Gandhi is cited with 2 contempt charges because she has twice refused to testify before the special investigative commission.

ISRAEL

(See also *Intl, Middle East*)

Jan. 5—A government spokesman reports that settlers in the Sinai have begun bulldozing for construction of 8 new settlements.

Jan. 8—Cabinet Secretary Aryeh Naor says that the Cabinet has rejected plans to establish new settlements in the Sinai; the Cabinet votes to strengthen existing settlements in the Sinai and to increase the amount of land under cultivation.

Jan. 9—Finance Minister Simha Ehrlich submits the government's $13 billion budget proposal to Parliament.

Jan. 12—In Rome, Foreign Minister Moshe Dayan meets with Pope Paul VI; they reportedly discuss the prospects for peace in the Middle East.

Jan. 13—The Cabinet approves the construction of 3 new Israeli settlements on the West Bank of the Jordan River.

Jan. 22—The Cabinet votes to suspend peace talks with Egypt in Cairo because of a series of what it regarded as anti-Jewish articles in the Egyptian press.

Jan. 29—The Cabinet votes unanimously to resume negotiations in Cairo.

ITALY

Jan. 11—Under mounting pressure from left-wing forces to include the Communist party in the coalition government, Christian Democratic party secretary Benigno Zaccagnini issues a statement saying that the government will not accept direct Communist participation in the government.

Jan. 12—In Washington, D.C., the U.S. State Department issues a statement urging that the Italian government resist pressures by Communists for participation in the government.

Jan. 16—Prime Minister Giulio Andreotti submits his resignation to President Giovanni Leone; Andreotti lost the support of the Communists, Socialists and Republicans, who were demanding the inclusion of Communists in the government.

Jan. 19—President Leone asks Andreotti to form a new coalition government.

Jan. 20—The leadership of the Christian Democratic party instructs Andreotti to request Communist party support for a new government without giving Communists Cabinet positions.

Jan. 26—Secretary General Enrico Berlinguer of the Communist party addresses the opening session of a 2-day conference of the central committee; he continues to demand Communist participation in the government.

JAPAN

(See also *U.S., Foreign Policy*)

Jan. 21—In his annual policy speech, Prime Minister Takeo Fukuda expresses his government's determination to increase imports in order to reduce the excessive trade surplus.

JORDAN

Jan. 1—In Teheran, Iran, U.S. President Jimmy Carter meets with Jordanian King Hussein for talks on the Middle East peace negotiations.

KOREA, NORTH

Jan. 21—President Kim Il Sung meets with Soviet Politburo member Dinmukhamed A. Kunayev in North Korea; this is the 1st reported meeting between a Soviet official and President Kim in more than 2 years.

KOREA, SOUTH

(See *U.S., Political Scandal*)

LEBANON

Jan. 1—In Beirut, some 10,000 Palestine Liberation Organization (PLO) supporters stage the largest PLO rally in 13 years to express their demand that they be included in any Middle East peace negotiations.

Jan. 4—In London, PLO representative Said Hammami, a close aide of Yasir Arafat's, is assassinated.

NICARAGUA

Jan. 10—In Managua, Pedro Joaquin Chamorro Cardenal, the editor and publisher of *La Prensa*, the only opposition newspaper, is shot and killed by men in an automobile.

Jan. 27—After 5 days of a nationwide strike by labor and business groups protesting the murder of Chamorro, President Anastasio Somoza Debayle rejects the strike leaders' demand that he resign.

NIGERIA

(See *U.S., Foreign Policy*)

PAKISTAN

Jan. 1—Head of the ruling military junta Mohammad Zia ul-Haq orders that all charges be dropped against opposition leader Khan Abdul Wali Khan and 40 politicians currently on trial for conspiracy. The charges were levied 3 years ago during the administration of Prime Minister Zulfikar Ali Bhutto.

PANAMA

(See *U.S., Legislation*)

PHILIPPINES

Jan. 16—Following disclosure of payments by the U.S. Westinghouse Electric corporation to the Herdis conglomerate, a company owned by Herminio T. Disini, a close friend of President Ferdinand E. Marcos's, Marcos orders the conglomerate to divest itself of 3 subsidiary companies.

PORTUGAL

Jan. 26—Prime Minister Mário Soares forms a Socialist-led Cabinet by bringing conservative Social Democratic Center party members into his Cabinet.

RHODESIA

Jan. 9—Under a newly effective law, foreign journalists must submit all reports on the war with guerrillas to a military censor for approval.

Jan. 25—In a news conference in Salisbury, Prime Minister Ian Smith predicts that an agreement on majority rule with the black nationalist leaders is imminent. It is reported that the conferees have agreed to the concept of one man, one vote, including guarantees for 10 years to the white minority.

SAUDI ARABIA

Jan. 3—U.S. President Jimmy Carter arrives in Riyadh for a visit with Saudi officials.

Jan. 24—In Washington, D.C., U.S. Secretary of Energy James Schlesinger reports that Saudi Arabia plans a modest increase in oil production for the 1980's, bringing the sustained output to 12 million barrels of oil a day compared to the current production of about 10 million barrels a day.

SOMALIA

(See also *Ethiopia*)

Jan. 21—In Bonn, the West German government agrees to give Somalia $11.8 million in credits because of Somalia's assistance to West German commando units who rescued hostages held by terrorists on a plane at Mogadishu airport in October, 1977.

Jan. 31—A shipment of food arrives from the U.S., the first shipment under a new $6 million direct aid agreement signed in December.

SOUTH AFRICA

Jan. 29—In Soweto, Zulu Chief Gatsha Buthelezi addresses 10,000 blacks, the largest black group ever gathered in Soweto.

SPAIN

Jan. 20—The government issues pardons to the Basque murderers of Prime Minister Luis Carrero Blanco, who was killed in 1973.

Jan. 25—In Barcelona, the former mayor of Barcelona, Joaquín Viola Sauret, and his wife are killed by a bomb blast in their home.

SRI LANKA

Jan. 31—Under a subsidy reduction program announced in November, the government withdraws rice and sugar subsidies for 7 million, half the population, who earn more than $18 a month. Citizens hold protest meetings.

THAILAND

(See *Cambodia*)

TUNISIA

Jan. 26—A general strike called by the General Union of Tunisian Workers to protest the government's economic policies affects most of the country's major cities. The government declares a state of emergency because of the clashes between demonstrators and police.

Jan. 29—Former Interior Minister Ahmed Mestiri, an opponent of the government, estimates that nearly 100 people were killed by government troops in the rioting last week.

It is reported that Habib Achour, leader of the General Workers Union, and 8 other union leaders have been taken into custody by police for their role in the general strike.

TURKEY

Jan. 1—After yesterday's parliamentary vote of no confidence, Prime Minister Suleyman Demirel submits his resignation to President Fahri Koruturk. President Koruturk asks former Prime Minister Bulent Ecevit to form a new government.

Jan. 17—Parliament votes to confirm the new Socialist coalition government headed by Ecevit.

Jan. 20—In Ankara, U.S. Secretary of State Cyrus R. Vance meets with Foreign Minister Gunduz Okcum to discuss the Cyprus question. Okcum warns Vance about meddling in the Cyprus dispute.

U.S.S.R.

(See also *Intl, Science and Space; Cambodia; Canada; North Korea*)

Jan. 11—Tass, the government press agency, reports that a space ship with 2 astronauts on board has docked successfully with the Salyut 6 research station; the astronauts join 2 other men who docked their craft with the space station in December.

Jan. 24—A Soviet satellite, Cosmos 954, carrying a nuclear reactor disintegrates over an uninhabited area of northwestern Canada. The Soviets reportedly informed the U.S. government on December 19 that the satellite was disabled.

UNITED KINGDOM

Great Britain

Jan. 12—Delegates of the Fire Brigades Union, representing 33,000 firemen, vote to end the nine-week strike and accept a 10 percent wage increase.

Northern Ireland

Jan. 9—In London, Protestant attenders at interparty talks on Northern Ireland walk out because of remarks made by Prime Minister of Ireland John Lynch.

UNITED STATES

Administration

Jan. 7—Secretary of Health, Education and Welfare Joseph Califano, Jr., issues new regulations that will bar federal funding from agencies that discriminate against the handicapped.

Jan. 8—Comptroller of the Currency John Heimann proposes the imposition of restrictions on American banks lending money to foreign governments and to companies controlled by foreign governments.

An Internal Revenue Service spokesman confirms that President Jimmy Carter has halted the development

of an $850-million computer system for monitoring taxpayers' records.

The Commerce Department reports that the states collected a total of $101 billion in tax revenues for fiscal 1977, up 13.2 percent over the previous year.

Jan. 10—Vice President Walter Mondale begins a "listen and learn" tour of 7 Rocky Mountain states.

The Department of Justice releases a report that details evidence of petty corruption among upper level officials of the Federal Bureau of Investigation when it was headed by J. Edgar Hoover; since the incidents took place more than 5 years ago, no prosecution is planned.

Jan. 11—Secretary of Health, Education and Welfare Califano announces that his department is working on proposals to persuade Americans to stop smoking; the proposals would increase the federal tax on cigarettes, ban smoking on commerical airliners, and increase from $1 million to $6 million the money spent on education on the dangers of smoking.

Jan. 13—Former Federal Reserve Board chairman Arthur Burns announces his resignation from the board, effective March 13, in order to allow his successor, chairman G. William Miller, "the fullest opportunity" to establish his leadership.

Jan. 19—Attorney General Griffin Bell announces the selection of U.S. Appellate Court Judge William H. Webster, a Republican, as director of the FBI.

President Jimmy Carter delivers his State of the Union address to Congress; he calls for a strong energy program, an economic program that will include a $25-billion tax reduction, the creation of a new Cabinet Department of Education, separating education from the Department of Health, Education and Welfare, and Senate approval of the Panama Canal treaties. President Carter says that he considers the State of the Union "sound."

Jan. 21—President Carter submits modest tax reform proposals to Congress, including some tax reduction and revenue-raising revisions of the tax code that will keep the economy "humming" through 1979.

Jan. 23—In his budget message to Congress, President Carter asks for a $500.2 billion budget, with a $60.6 billion deficit for fiscal 1979; the President says that the $25-billion tax cut he proposes will put new vigor into the economy. The proposed budget for defense spending is up 3 percent to $117.8 billion.

Jan. 24—President Carter signs an executive order designed to reorganize the administration of foreign intelligence activities and to place curbs on those agencies; the Senate and House select committees on intelligence must hold hearings on the order.

Jan. 26—Secretary of Health, Education and Welfare Joseph Califano, Jr., announces the regulations under which the government will finance abortions for victims of rape or incest; the crime must be reported to a law enforcement or public health agency within 60 days.

In a special message to Congress, President Carter calls for the expenditure of $50 billion over the next 5 years for highways and mass transit.

Jan. 31—In Alexandria, Va., an American AID official and a Vietnamese are arrested on charges of spying for Vietnam.

Civil Rights

Jan. 6—U.S. district court Judge Walter Skinner in Boston and a federal jury rule that the Indians in the town of Mashpee on Cape Cod did not constitute a tribe on key legal dates in their history and therefore cannot claim a large portion of land in the town; the judge does not dismiss the claim of the Indian tribe to 11,000 acres.

Economy

Jan. 7—Citibank raises its prime rate to 8 percent; 3 other major banks follow suit.

The Federal Reserve Board raises its discount rate to 6.5 percent.

Jan. 11—The Department of Labor reports a 6.4 percent unemployment rate for December, the lowest since 1974.

Jan. 17—The Federal Reserve Board reports that the nation's industrial output rose 0.2 percent in December.

Jan. 18—The Commerce Department reports that housing starts climbed in December at an 8.2 percent rate.

The Commerce Department reports that the growth rate of the gross national product slowed to 4.2 percent in the 4th quarter of 1977.

Jan. 20—The Labor Department says that the consumer price index rose by 6.8 percent in 1977.

In an economic message to Congress, President Jimmy Carter calls for voluntary restraints on price and wage increases.

Jan. 30—The Commerce Department reports that in 1977 the U.S. had a trade deficit of $26.7 billion, the largest in the nation's history.

Jan. 31—The U.S. Steel Corporation reports its 4th quarter earnings down 89 percent: its total 1977 profit of $137.9 million is the company's lowest in 30 years.

The composite index of leading indicators rises 0.7 percent, the 6th consecutive monthly rise.

Foreign Policy

(See also *Intl, Middle East; Cambodia*)

Jan. 1—President Jimmy Carter confers with King Hussein of Jordan in Teheran, Iran; it is reported that the King has not been persuaded to join the Middle East negotiations in Cairo.

Jan. 2—President Carter addresses the Indian Parliament in New Delhi, India.

Jan. 3—President Jimmy Carter meets with Saudi Arabian leaders in Riyadh, Saudi Arabia, to discuss Middle East diplomatic and oil problems.

Jan. 4—The Treasury Department and the Federal Reserve Board announce that they will act to support the declining U.S. dollar.

President Carter arrives in France to meet with French leaders.

President Carter confers with Egyptian President Anwar Sadat in Aswan, Egypt; the two Presidents suggest that the Palestinians should "participate in the determination of their own future."

Jan. 6—President Carter visits NATO headquarters in Brussels and says that the U.S. will include its European allies in negotiations with the Soviet Union to limit U.S. and Soviet nuclear arms.

Returning to Washington, D.C., after an 8-day trip to 7 countries on 3 continents, President Carter says the U.S. will endorse a limited-choice referendum for Palestinians living on the West Bank of the Jordan River and in the Gaza Strip; he says that an independent Palestinian nation will not be one of their alternatives.

Jan. 9—The Treasury Department reduces by one-half the penalties assessed against 5 Japanese carbon steel manufacturers for dumping steel in the U.S. market.

Jan. 11—The State Department makes public a 15-nation agreement on a code to safeguard nuclear technology exports from being used for military purposes.

Secretary of State Cyrus Vance leaves on a speaking tour of the U.S. to secure support for the Panama Canal treaties.

Jan. 12—In Tokyo, President Carter's special trade representative, Robert Strauss, opens 2 days of talks with Japanese officials aimed at settling major trade issues between the U.S. and Japan.

Jan. 13—U.S. and Japanese negotiators in Tokyo agree on new measures to ease trading tensions between the U.S. and Japan.

Jan. 15—State Department officials say that the U.S. will cut military aid to Zaire almost in half and will start a security assistance program to Nigeria.

Jan. 16—State Department spokesman John Trattner denies that the U.S. will reduce military aid to Zaire and offer increased aid to Nigeria.

Jan. 28—President Carter invites Egyptian President Anwar Sadat to Washington, D.C., next weekend to discuss Middle East negotiations.

Special Representative for Trade Negotiations Robert Strauss says that President Carter has ruled out increases on the tariffs of chrome alloys imported from South Africa.

Labor and Industry

Jan. 21—A jury decides against the Eastman Kodak Company in a suit by Berkey Photos Incorporated; Berkey had filed a civil action against Kodak charging that the world's largest photographic concern was monopolizing the amateur photographic business.

Jan. 31—Negotiations are stalled as the nationwide coal strike enters its 9th week.

Legislation

(See also *Administration*)

Jan. 4—Meeting with Panamanian Supreme Leader of the Revolution Brigadier General Omar Torrijos Herrera in Panama, Senator Howard Baker (R., Tenn.), Senate minority leader, informs the Panamanian leader that the Senate will not approve the Panama Canal treaties without changes clarifying the U.S. right to defend the canal and granting U.S. ships priority of passage after Panama gains full control over the canal in the year 2000.

Jan. 13—Senator Hubert Humphrey (D., Minn.), a former Vice President, dies of cancer.

Jan. 19—The second session of the 95th Congress convenes.

Jan. 25—The House Armed Services Committee releases a Central Intelligence Agency study that shows that dollar-wise the Soviet Union invested 20 percent more than the U.S. in armament for the period 1967 to 1977.

Minnesota Governor Rudy Perpich appoints Muriel Humphrey to fill the unexpired Senate term of her late husband, Hubert Humphrey.

Military

Jan. 31—Army Secretary Clifford L. Alexander says the Defense Department has chosen a West German gun for its new battle tank as part of a plan to standardize NATO weapons. Congressional approval is required.

Political Scandal

Jan. 5—Leon Jaworski, special counsel to the House Ethics Committee investigating alleged South Korean influence buying in Washington, D.C., says, "We have requested that the South Korean government make [Tongsun Park] available for testimony in the proceedings of the committee. . . ."

Jan. 31—The South Korean ambassador to the U.S. says that Tongsun Park has his government's permission to testify before the House Ethics Committee.

Jan. 11—Accompanied by his attorney, Tongsun Park signs an agreement in the U.S. Embassy in Seoul whereby he will submit to interrogation in Seoul and return to the U.S. as a witness at any trials that result from the investigation of influence buying by South Korea in Washington, D.C.

Jan. 14—It is reported that Tongsun Park told U.S. Justice Department investigators in Seoul that he distributed $750,000 in covert gifts to American officials between 1970 and 1975.

Jan. 20—Attorney General Griffin Bell dismisses U.S. Attorney in Philadelphia David Marston, a Republican, for political reasons; Marston has been investigating 2 Democratic congressmen, Representative Joshua Eilberg and Daniel Flood, both of Pennsylvania, on conflict of interest charges.

Jan. 21—Bill Brock, Republican national party chairman, asks Congress to investigate Marston's dismissal; both Brock and Marston have accused the administration of yielding to pressure for his dismissal from Democratic Representative Eilberg.

Jan. 23—President Jimmy Carter and Attorney General Griffin Bell tell Justice Department investigators that when they decided to dismiss David Marston they did not know that Marston was investigating Joshua Eilberg; Eilberg urged the President to dismiss Marston.

Jan. 24—Justice Department investigators say that President Carter and Attorney General Bell have not been guilty of improper conduct in the dismissal of David Marston.

Jan. 26—A senior Justice Department official in Washington, D.C., reports that Tongsun Park has given evidence in Seoul indicating that between 15 and 18 current members of Congress have accepted his gifts.

Jan. 30—At his news conference in Washington, D.C., President Carter says that his involvement in the ouster of David Marston as U.S. Attorney in Philadelphia was a "routine matter."

Politics

Jan. 17—According to Common Cause, congressional candidates spent $99 million in their 1976 campaigns, $25 million more than they spent in 1974.

Supreme Court

Jan. 9—Without comment, the Supreme Court lets stand a lower court decision that rejected a challenge by 2 couples to the "marriage penalty" in the tax laws.

The Court refuses to consider the constitutionality of court orders in 2 states, Ohio and South Carolina, that limit news coverage of criminal trials; the Court also sends a similar Pennsylvania case back to the lower court on procedural grounds.

Jan. 18—By a 5-4 vote, the Supreme Court permits prosecutors to threaten defendants with a second more serious charge if the defendant refuses to plea bargain in relation to the first charge.

VIETNAM

(See *Cambodia*)

ZAIRE

(See *U.S., Foreign Policy*) □

	Population 1974 (000)	GNP Per Capita Amt. (US$s)	GNP Per Capita Growth Rate (%) 1960-74	GNP Per Capita Growth Rate (%) 1965-74	Population Growth Rate (%) 1960-74	Consumption of Energy Per-capita Per-habitant (kg. coal eq. Per Capita). 1972	Consumption of Energy Per-capita Per-habitant (kg. coal eq. Per Capita). 1975	Net Imports of Raw Petroleum and Energy Petroleum Products (thousands of $s) 1973	Net Imports of Raw Petroleum and Energy Petroleum Products (thousands of $s) 1974	Share of Net Petroleum Imports in Total Imports (%) 1973	Share of Net Petroleum Imports in Total Imports (%) 1974	Aid Receipts from OPEC and Multi-lateral Agencies 1974	IMF Oil Facility[6] 1974
Afghanistan[1]	16.311	110	0.5	1.1	2.2	44	52	9,375[3]	34,200[3]	5.1[3]	14.1[3]	8.30[3]	—
Bangladesh	76.200	100	−0.5	−1.9	—			16,075[3]	60,120[3]	2.4[3]	7.8[3]	60.04	42.18
Benin (PR)[1,2]	3.027	120	0.7	0.8	—			2,350[3]	7,290[3]	2.1[3]	5.0[3]	1.30	—
Bhutan[1,2]	1.150	70	−0.3	−0.2	—			—	—	—	—	—	—
Botswana[1]	0.69	n.a.	n.a.	n.a.	2.3			—	—	—	—	2.70	—
Burundi[1,2]	3.655	90	1.3	1.3	2.0	17	13	1,637	2,661	5.2	6.2	3.00	2.82
Central African Empire[1]	1.748	210	0.4	0.8	—			1,375[3]	5,490[3]	2.6[3]	11.9[3]	2.40	2.30
Chad[1]	3.952	100	−1.2	−1.5	1.8	18	39	1,225[3]	3,960[3]	1.5[3]	4.3[3]	19.23	9.71
Democratic Yemen[1,2]	1.632	220	n.a.	−4.3	—			17,400[3]	38,700	10.2[3]	20.7[3]	18.86	—
Ethiopia	27.240	100	2.2	1.5	2.2	33	29	15,780	32,191	7.4	11.8	15.30	—
Gambia		n.a.	n.a.	n.a.	—			1,876	2,160[3]	5.1	4.7[3]	1.79	3.65
Guinea	5.90	120	0.0	0.1	2.8	98	92	6,275[3]	23,670[3]	9.0[3]	29.6[3]	29.80	3.97
Haiti	4.514	170	−0.1	0.7	1.06	31	30	3,765	11,441	4.9	10.3	—	—
Laos (PDR)[1,2]	3.260	70	1.8	2.0	2.4	82	63	9,717	6,539	17.8	10.1	—	—
Lesotho[1,2]	1.191	140	4.2	3.7	2.2			—	—	—	—	1.40	—
Malawi	4.958	130	3.9	4.7	2.6	55	56	6,996	17,234	4.9	9.2	7.50	4.18
Maldives	0.12	n.a.	n.a.	n.a.	—			—	—	—	—	—	—
Mali[1]	5.560	80	0.9	0.4	2.2	25	25	2,125[3]	7,560[3]	2.0[3]	6.0[3]	12.12	—
Nepal[1]	12.320	100	0.4	0.0	2.0	15	10	2,000[3]	6,660[3]	2.0[3]	8.0[3]	—	—
Niger	4.480	120	−1.8	−3.8	2.7	29	35	6,665	7,653	7.7	7.9	6.32	—
Rwanda[1,2]	4.058	80	−0.2	1.4	3.3	13	14	2,679	4,947	8.7	8.5	1.00	—
Sikkim[1,5]	n.a.	n.a.	n.a.	n.a.	—			—	—	—	—	—	—
Somalia[2]	3.100	90	−0.3	1.1	2.4	34	36	1,800[3]	7,200[3]	1.7[3]	5.0[3]	64.25	29.65
Sudan[2]	15.227	230	1.7	4.3	2.2	135	140	24,672	37,874[4]	5.1	5.8	138.64	5.22
Uganda	11.186	240	1.8	0.7	—	69	55	340[4]	618[4]	0.3[4]	0.5[4]	24.40	29.65
Tanzania	14.351	160	2.6	2.3	2.9			33,625[4]	118,043[4]	7.5[4]	15.5[4]	16.73	—
Upper Volta[1]	5.760	90	−0.1	−0.5	2.9	15	20	1,225[3]	4,860[3]	1.3[3]	3.4[3]	8.59	—
Western Samoa[2]	0.16	n.a.	n.a.	n.a.	1.3	122	160	627	1,080[3]	2.9	4.2[3]	—	—
Yemen (AR)[2]	6.379	180	n.a.	n.a.	3.4	21	49	5,293	11,250[3]	4.2	5.9[3]	79.67	—
							Total	174,897	453,401	4.8	9.5	523.34	133.64

[1] = landlocked. Consult Goodes, *World Atlas* (Chicago: Rand McNally, 1974).
[2] = tentative estimates.
[3] = based on estimates.
[4] = inflationary figure. For further explanation consult the original document.
[5] = included in Indian population. The final political "status has not yet been determined." Consult *U.N. Statistical Yearbook 1976.*
[6] = pro-rated figures.
n.a. = not available.
— = indicates lack of data.

Sources: Adapted from the United Nations Economic and Social Council, *Recent Energy Trends and Future Prospects, 1977,* Table 9 and Table 10, in which columns 8, 9, 10, 11, 12, and 13 appear; columns 1, 2, 3, 4, and 5 from *World Bank Atlas, 1976,* pp. 4-5, apply to states with inhabitants of one million or more; unless otherwise noted, references are to these two volumes; columns 6 and 7 are based on the United Nations, *Statistical Yearbook 1976,* pp. 372-375. Population estimates of countries with less than one million (excluding Sikkim) are those of the United Nations, *World Statistics in Brief* (1976). Sikkim population is estimated to be 200,000

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